THE

ELECTRICAL REVIEW.

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J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893

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"FAIRPLAY" AND SOUNDING APPARATUS.

AFTER every calamity by land or sea, from a big railway smash to the capsize of a row-boat, certain people find a pleasure in writing to the papers to tell us how it all happened, and to say what ought to be done to prevent such mishaps. In this way managers of railways and steamship companies, who, of course, know but little of their business, derive some information and much amusement from their amateur advisers. No doubt the officials of the North Eastern Railway Company are by this time aware that they have much to learn in the conduct of railway traffic; and the owners of the *Roumania* have at length been told the secret of successful navigation.

When the *City of Chicago* was wrecked, we were told that this disaster would have been avoided had a certain sounding apparatus been used; this might or might not have been the case, but since a well-known admiral and a well-known naval professor said so, we ought, of course, to believe it. Now that the *Roumania* has been wrecked, this same professor writes to the papers and again sings the praises of the aforesaid sounding apparatus; and, furthermore, urges "that the use of continuous sounding machines in dangerous waters may soon be a matter for legislative interference."

In this strain, *Fairplay*—a contemporary holding a deservedly powerful position in the shipping world—runs on for nearly a column, throwing out many a subtle inuendo concerning the "disinterestedness" (?) of this "same professor" and this "well-known admiral," in seizing the opportunity for urging the claims of James's sounding apparatus.

Now, it is not in our province to brand any new invention with any statement likely to be used in advancing the particular interests of its promoters, neither do we wish to place the black mark of disapproval upon James's "submarine sentry," Colonel Vetch's new submarine indicator, or any other worthy effort in the direction of preventing disaster at sea. We regard them all as deserving of encouragement rather than of "cold water treatment." Their object is distinctly praiseworthy, and no one will complain if those who promote them seek also their own financial benefit; it is difficult, in fact, for anyone who possesses any humanitarianism to adopt any other attitude. Hence we have to look further in order to understand the position which *Fairplay* assumes. Personally, the editor is of opinion we find, that we "may have too much of this automatic safety business. Reliance on a machine which may or may not work is apt to lead to a neglect of the older and safer rule-of-thumb process of taking frequent and careful soundings. Unless it can be averred that an automatic process can never by any possibility fail, it must obviously be rash to trust implicitly to such contrivances; and if they are not to be implicitly trusted, what is the use of them?"

And this is an extract from a paper published on November 18th, 1892! *Fairplay* actually complains that our Atlantic liners and P. & O. steamers are "veritable inventions museums or exhibitions." Such antiquated notions would have disgraced the time when steam was first substituted for sail-power, or when the mariner's compass began to be used, and sailors to rely on it, instead of continuing to "the old rule of thumb method" of watching the stars.

Those who are responsible for the editorial department of our ultra-conservative contemporary cannot be great travellers, or they would appreciate all those ingenious little devices, the outcome of intelligence and civilisation, which reduce the discomforts, and minimise the dangers of ocean journeys.

A PHOTOGRAPHIC METHOD OF MAPPING THE MAGNETIC FIELD.

THE common method of obtaining a cross-section of the field of force of a magnet by means of iron filings is very satisfactory when only temporary representations of the field are desired. Methods of making such a representation of a more or less permanent character are not unknown, but there has been wanting hitherto a suitable method of making a permanent map of the magnetic field. In producing a suitable method the art of photography has recently been impressed into service. While studying the magnetic field, it was suggested by Mr. John Lamay that a permanent record could be obtained by securing a map upon blue print paper, exposed to the sun and washed as usual. The results obtained in a preliminary experiment were beautiful; but it was of course necessary to repeat the process for every copy of the field desired. It occurred to Mr. C. B. Thwing, of the North Western University, U.S.A., that by employing a photographic dry plate, in place of blue print paper, a negative would be obtained from which any desired number of prints could be made, and which would have the additional advantage of representing the figures "in their true colours." The following description of the method employed, as described by Mr. Thwing in a recent paper, will probably prove of value to others who may be engaged in the study of the magnetic field. For obtaining the field of a bar-magnet, for example, the magnet is placed upon a large card, previously marked with concentric circles and parallel lines to facilitate the centreing of the magnet. The photographic plate is placed film-side up directly upon the magnet. Iron filings, contained in a loosely woven flannel bag, are shaken from a distance of about one foot from the plate upon its surface. The plate is then held at two points and tapped gently until the filings have arranged themselves along the lines of force. The room is, of course, all this time illuminated by non-actinic light. The next point in the process is the exposure. This is made by turning the key of an incandescent lamp, supported at a convenient distance directly above the centre of the plate. The position of the lamp is a matter of considerable importance, as the light from a gas jet at one side of the plate will cause the filings to cast a shadow and give an incorrect representation of the lines of force. When an electric light is not convenient, very fair results may be obtained by holding a lighted match above the plate. It is more difficult, however, to time the exposure correctly by this method, and the match will often so cast a shadow upon the plate as to cause irregularity of illumination. After exposure, the plate is tipped so that the filings may slip off, and the few which still cling to the surface of the film are carefully removed by means of a fine camel-hair brush. The negative is then fixed and developed in the usual way. The plates employed should be of a sort to give the strongest possible contrasts; a slow plate gives the most satisfactory results. For making prints from these negatives, any paper may be employed which will give good black and white tones. Reduced positives from these negatives make very brilliant lantern slides by means of which a great variety of magnetic fields may be exhibited to a large audience. The want of such lantern slides, for illustrating lectures has been felt by many. Some of our readers may remember a paper by Prof. Houston in the *Electrical Engineer*, New York, in which a method very greatly resembling the above is described, and which is, in fact, precisely the same in principle. This furnishes another instance of the simultaneous invention of a process by two investigators, each working wholly without knowledge of what the other was doing.

The Action of an Electric Current in Displacing a Magnet on Mercury.

THIS subject has recently been brought before the Paris Academy of Science by Mons. C. Décharme in a short paper, in which he states the results of some observations recently made by him. The more important of these may be summed up as follows:—Using perfectly pure mercury (an essential condition) for supporting a magnetic needle and leading the current into the mercury by dipping conductors carrying it into the mercury at different points, it was found that before assuming the position of equilibrium and thus conforming to the well known law of Ampère, the needle travels here and there over the surface of the mercury in a curious way, which appears to be governed by the ease with which it can travel in a direction parallel to its longer axis, and the difficulty of moving in a direction perpendicular to this axis. One of the most interesting effects was produced by making the current cross the surface in a direction perpendicular to the longer axis of the needle, with the negative pole of the current on the left of the south-seeking pole of the needle. Under these circumstances it was observed that the needle first moved away in a direction parallel to its longer axis, then turned round and finally returned, taking up the normal position according to Ampère's law. The paper in which these and other results are arranged may be consulted in the *Comptes Rendus*, Vol. cxv., No. 18, pp. 651—52.

Choking Coils.

THERE is eddy current loss of power in all the conducting masses of a choking coil. Hence a choking coil is really a transformer with one primary coil and many secondaries and much magnetic leakage. In a transformer with many coils, whether or not they have magnetic leakage, it may be shown that any given group of secondaries of given number of turns and resistances may be replaced by one secondary without affecting the currents in the other coils; and we may take a choking coil to be a transformer with a primary coil of N turns, and resistance R ohms, with C ampères flowing at any instant, the potential difference at its terminals being V, and a secondary coil closed on itself of n turns, resistance r ohms,

and current c ampères. The Proceedings of the Physical Society for October contains a valuable Note by Prof. John Perry, D.Sc., F.R.S., with an indication that we may shortly expect further contributions from him upon this interesting subject of choking coils. The treatment in this preliminary note is of a mathematical nature; equations being deduced which it will be useful to compare with those which are employed in practical transformer calculations. The Professor towards the end of his paper throws out the suggestion that in a choking coil we have, perhaps, found what has long been looked for—a method of increasing frequency by magnetic means.

The Electric Motor and the Farmer.

A RECENT article by Mr. W. N. Black under the above heading, though ultra-sanguine in tone and somewhat inflated in style, nevertheless contains much mental *pabulum*, or at least food for reflection on the part of those whose energies are being devoted to the carrying of electricity and its applications into various fields of enterprise. Though it may sound like an eccentric use of language to aver that the electric motor has a political and social aspect, Mr. Black contends that it has, and proceeds with considerable acumen to canvass the results which may be expected to ensue on the general introduction of this kind of machinery into agriculture. He discusses first the question of economy, and adduces figures which, taken along with certain indicated advantages, prove to his satisfaction that the use of electromotors would effect a great saving in the cost and maintenance of horses and rolling stock, an enormous economy of time and a greatly enhanced value of farm lands. The first effect upon the farmers would be exerted in the direction of their temper, to be followed by a determination on their part to create electric railroads, power stations, and locomotives for highway use out of their own resources, independently of outside or "company" help. In the proximity of towns and villages they will see further the opportunity to supply manufacturing power and electric light at a profit, and will continue to enlarge the field of operation "till farming becomes an elegant diversion rather than an exclusive pursuit." But what will be the effects on the movement of population? This, one of the burning questions of these *fin de siècle* days, is very soon disposed of. Rural districts will in time come to present as many advantages as the urban, says Mr. Black; and by very plausible, if withal somewhat specious argument, he contends that "substantially anything on which the city can now base a claim to superiority will soon be found in the country in about equal perfection," and thus the electro-motor will help to check the flow of blood to the now badly congested heads of our political organisation. "What the farmer needs," says Mr. Black, "is something to bring him in harmony with the financial system, and this is precisely the work that may be allotted to the electric motor." To which, in the words of the old bard of Avon, we beg leave to say, "'Tis a consummation devoutly to be wished."

Nitric Acid from the Air by Electricity.

SOME of our readers may be inclined to smile incredulously as they read this title and to inquire whether any one is going to promote another new company. It is certainly a novel idea that would lead the ubiquitous exploiter to search for El Dorado in the atmosphere. It must however be taken seriously. The production of small quantities of nitrous and nitric acid during the passage of electric discharges through moist air is well known. Recently Lepel has undertaken an investigation to determine the precise nature of the chemical changes taking place, with a view to increasing the yield. The first product, when the spark passes through air, is apparently nitrogen dioxide, which becomes nitrogen tetroxide through reoxidation in contact with the air. This reacts with the aqueous vapour always present in the atmosphere, forming nitric acid and setting free nitrogen dioxide again, thus:

$$6\,N\,O_2 + 2\,H_2\,O = 4\,H\,N\,O_3 + N_2\,O_2$$

On further passing the sparks, however, decomposition of the nitrogen oxides into their constituents takes place, so that in a closed space a limit is now reached beyond which there is no further increase in the production of nitric acid. In his later experiments Lepel used a slowly moving atmosphere (thus producing the condition of unlimited supply existing in the air), varying the pressure and the spark through a wide range; and he has already increased the amount of combination up to ten per cent. of the air employed. The best effect was produced when the air was exposed under increased pressure to a series of parallel spark-discharges in the same tube. The air in the tube was charged intermittently, the gases passing into a large absorption vessel containing water or alkali solution. A Toëpler machine having 66 revolving plates was used, and Lepel thinks that with the high voltage discharges lately produced by Tesla and others, the problem of producing nitric acid from the atmosphere may be solved in such a way as to prove a commercial success. Of course, the whole thing is still (and literally) *in nubibus*.

A Mercury Arc Light.

SOME interesting demonstrations were given at a recent meeting of the Physical Society of Berlin by Dr. Arons, who exhibited an arc light between mercurial electrodes in *vacuo*. The light was of a very brilliant quality, but was rather unsteady at the anode: No variations were observed at the anode when its intensity was very nearly equal to that of an ordinary commercial arc light. In spite of this, however, the temperature was by no means high: it was hotter at the cathode than at the anode. A spectroscopic examination of the light disclosed the existence of a yellow, a green and a blue line, but nearly twenty new lines were observed in addition to those due to the incandescence of the mercury. Some researches on the use of amalgams of mercury are in progress, from which some interesting results may be expected; already fairly good results have been obtained with sodium amalgam. The "telephone method" showed that the current is discontinuous, but no measurements of the resistance of the arc have yet been successful.

Electrical Resistance as a "Reagent."

THE phenomena of allotropy are amongst the most curious in chemistry, and few better examples can be found than those associated with carbon and sulphur. Recently some new forms or allotropes of silver have been discovered by Mr. Carey Lea, of Philadelphia, who has further shown that they can be converted into the ordinary silver by (1) heating, (2) mechanical means (pressure), (3) exposure to intense light, (4) exposure to electrical discharges, (5) treatment with different acid and salt solutions. Mr. A. Overbeck, who, in common with others whose inserest has been excited, has been examining these new forms of silver, finds that all operations which tend to approximate allotropic silver to ordinary silver, lessen its electrical resistance. We are being driven by numerous researches to admit that the electrical resistance of a substance is a very sensitive "reagent;" far more sensitive than any chemical process to show differences of molecular state.

IS THE EARTH A RESERVOIR OF ELECTRICITY?

[By SYDNEY F. WALKER.

Notwithstanding the advances which have been made in the knowledge of the principles of electrical science, it is still not uncommon to find writers upon electrical subjects, particularly those who write for the non-electrical public, giving the old statement which used to be given in text books of 20 years ago, that the earth may be considered to be an infinite reservoir of electricity. Even so able a writer as Prof. Garnett of the Durham College of Science, in a recent paper read before the North of England Mining Institute, advised members to consider that you may take out as much electricity as you please from the earth at any particular point, and return it to the earth again at any other point. Mr. Segundo also, in his little *brochure* on "Domestic Electric Lighting" recently issued, gives the same advice, and in addition, tells his readers that the quantity of electricity present in the earth and its surroundings is fixed. You cannot increase the quantity, nor can you decrease it.

In the writer's opinion, both of these views, though evidently given with the idea of simplifying the matter to those who have not had the opportunity of studying the question for themselves, are apt to be misleading. The earth is in no sense a reservoir of electricity. Nor can we be sure of taking an infinite quantity of electrical energy from the earth at any point, nor of passing it into the earth at any other point. We can only perform an operation which looks like this, when the electrical resistance of the intervening portion of the earth's crust, that lying between the two points, is sufficiently small to allow of the passage of a current of infinite strength. In rocky districts, for instance, where minerals are not present, the current which we can hope to get through any circuit of which the rocky portion of the earth's crust in the neighbourhood forms a part, is very small indeed, no matter how large the earth plates may be. In some districts it is found impracticable to get earth at all, even for the small currents used for telegraphic purposes. The earth, in fact, can only act as a conductor, and exactly as any other conductor. That is to say, the current which can be passed through any portion of its crust must be strictly in proportion to its dimensions, and to the specific resistance of the materials which lie in the path taken by the current.

It should be noted, of course, that these dimensions are not confined to the sectional area contained between the earth plates, or whatever the arrangement for making connection to earth may be. Currents will pass by every path that is open between the two earth connections, and these paths may extend in every direction round the direct path between the two connections to earth; but as the length of each of these paths becomes longer and longer, as their position becomes farther and farther from the direct path referred to, their resistance becomes larger and larger, provided the substances passed through are the same; so that for the practical purpose of conducting any given current, a limit is soon reached beyond which the outer paths do not appreciably affect the actual resistance offered to conduction, the resistance the engineer has to deal with.

The distance which these additional paths extend will, of course, vary with the conditions present, such as the size of the earth plates, the E.M.F. present between the earth connections, and the character of the substances forming the earth's crust at that particular place. The presence also of any other conductor, such as a body of water, a mineral vein, or another external conductor connected to earth at other points which lie in the path of the current, will considerably modify the path or paths taken by the latter. Thus, if in its passage from one earth connection to the other, the earth connection of another wire is encountered, a portion of the current will undoubtedly follow that wire to its destination, and return to its own earth connection by any other path that is open to it. But in all these cases, it is electrical conduction which is taking place, not a simple discharge in one place, and a re-demand in another.

So, too, it appears to the writer to be incorrect to say that the quantity of electricity present in the earth and its surroundings is fixed.

The quantity of energy is fixed, and the quantity of matter is fixed. You cannot create or destroy either energy or matter, you can only transform them. But this is going on constantly. The available quantity of heat is being constantly drawn upon for transformation into sound, light, electricity and magnetism, and is being as constantly added to by transformations from those sources of energy. So that it may very possibly happen that the quantity of electrical energy present at any moment in the earth and its surroundings is much more than at another moment. We have numerous instances of this in our midst. The quantity of electrical energy distributed from a large electric lighting station is very much larger during the busy evening hours than at any other period of the day. But this increased quantity has not been taken from any store except, of course, where accumulators are used, and then not in the sense that would be indicated if we look upon the earth as a reservoir. As is well known, in these cases the supply has not come from the earth in any sense. The conductors have been rigidly protected, if the installation has been properly laid out and kept in order, from any but a leakage connection with earth at all, and that is made as small as funds will allow. The electrical energy distributed from electric lighting stations has been obtained, by several transformations, from the heat energy stored in the coal by the action of the Sun during past ages, and is obtained by the combination of its elements with the oxygen of the atmosphere. It appears to the writer that the error arises from the attempt to follow too closely the analogy of water. There is a cycle of operations going on by means of which water is constantly passing and repassing from the earth, the oceans, rivers, &c., to the clouds, and back to the earth, rivers and oceans in the form of rain. And the immense body of water always present in and on the earth's crust may be looked upon as a practically infinite reservoir, from which the wants of man and the earth generally are supplied. But it is not correct to say even that the quantity of water present in and about the earth is constant. Heat, and electrical and electro-chemical actions are constantly going on, which transform what was water into other substances, and other similar actions are as constantly transforming portions of other substances into water. Possibly the average quantity present at various times may be about the same. But this is a very different thing from the absolute law which rules with matter and with energy.

Further, it must be remenbered that even the laws of the conservation of energy apply to the whole universe, not to that small portion only which we inhabit. Meteoric dust is constantly adding to the mass of the earth's crust; and, on the other hand, the earth is constantly radiating a portion of its heat into space, and so losing, so far as the earth is concerned, a portion of the energy stored in its interior. Yet, again, we are constantly receiving energy in the form of heat from our sun, moon, planets, and the other celestial bodies, so that a constant exchange both of matter and energy is going on every minute of our existence, maintaining, by the wonderful balance always preserved by nature's laws, those conditions most suitable to our well being, with the exception of those occasional times of variation which give rise to such terrible results in the form of earthquakes, hurricanes, &c.

The writer is fully cognisant of the difficulties which meet one when attempting to give those who have not studied electrical science some idea to work upon, which will enable them to follow the action of the electric current through the various phenomena which it produces; and he quite appreciates the temptation to give a simple analogy. But he has always regarded it as a dangerous plan to allow the analogy to be at all erroneous. If men study the matter at all, they will think a little deeper, and then the erroneous analogy confuses them, while it is not usually difficult for them to grasp the idea of a transference of energy from one form to another. Those who are likely to take the question up at all see this every time a bearing gets warm, if they will stop to think it out. To those who will not think a little deeper with the view of getting a sound basis for their studies, analogies are useless, however simple.

ALTERNATING CURRENTS AND THE E.M.F. QUANTITY DIAGRAM.

BY ARTHUR WHITWELL, M.A., A.R.C.Sc.

THE object of this paper is to illustrate an easy method of dealing with problems in which the currents or E.M.Fs. considered are variable, and to point out some of the properties of, and to show how to plot the E.M.F. quantity diagram. For the sake of illustration several cases will be dealt with in which an E.M.F., constant or varying according to some known law, is impressed in a circuit containing a condenser in series or forming a shunt.

First.—Let a constant E.M.F., E, be impressed in a circuit of resistance, R, having a condenser of capacity K in series (see fig. 1). If q be the quantity of electricity in the condenser at any instant $\frac{q}{K}$ will be the difference of potential of its terminals or the back E.M.F. The effective E.M.F. will be $E - \frac{q}{K}$, and a current will flow until $E - \frac{q}{K} = 0$; let q then be $= Q$. Draw a rectangle, O X P V, fig. 2, making the side, O V, represent E or $\frac{Q}{K}$, and the side, O X, represent Q, and join O P. The area of the rectangle then represents the whole energy expended and the area of the triangle, O X P, represents the energy stored in the condenser, for it is equal to $\frac{1}{2}$ O X . X P, that is to half the product of the quantity in the condenser and the difference of potential of its terminals. Therefore if we charge a condenser with a constant E.M.F., only half the total energy expended is stored in the condenser, the other half being expended in the circuit in the form of heat. If the circuit be supposed to have self induction the result would be the same, for if the condenser be discharged the whole of its energy would disappear as heat, and as the current goes through the same phases in charging as in discharging, except that they are reversed, the same amount of energy is expended in the form of heat in each case, that is, one-half the total energy expended in charging.

FIG. 1.

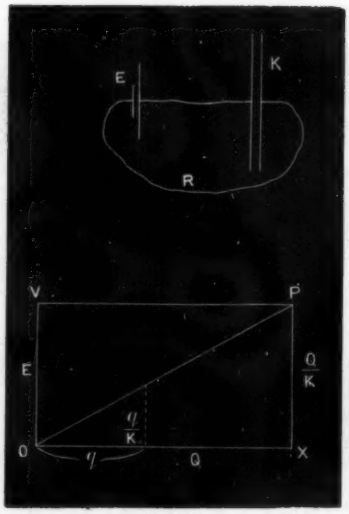


FIG. 2.

Secondly.—If the condenser be charged with a constant current C, we have the impressed E.M.F. $= C R + \frac{q}{K}$. Let Q now represent the quantity put into the condenser in unit time, then in the diagram, fig. 3, if O Y represent C R and X P, $C R + \frac{Q}{K}$ the area, O X P Y will represent the total energy expended, and the area of the triangle, P Y S, will represent the energy stored in the condenser in unit of time. If $C R = \frac{Q}{K}$ or $R = \frac{1}{K}$ the area of the triangle will be one-third of the whole figure, or the energy stored in the condenser is one-third of the total supplied.

Thirdly.—Let us take the case of a charging current uniformly increasing with the time. Call it t C. The quantity in the condenser at any instant will be $= q =$ average current $\times$ time $= \frac{t C}{2}$. $t = \frac{t^2 C}{2}$ the back E.M.F will be $= \frac{q}{K} = \frac{t^2 C}{2 K}$, and the impressed E.M.F. $= t C R + \frac{t^2 C}{2 K} = R \sqrt{2 q C} + \frac{q}{K}$. Calling the impressed and effective E.M.Fs., E and e respectively we have—

$$\left(E - \frac{q}{K}\right)^2 = 2 R^2 q C \qquad (1)$$

$$e^2 = 2 R^2 q C. \qquad (2)$$

FIG. 3.

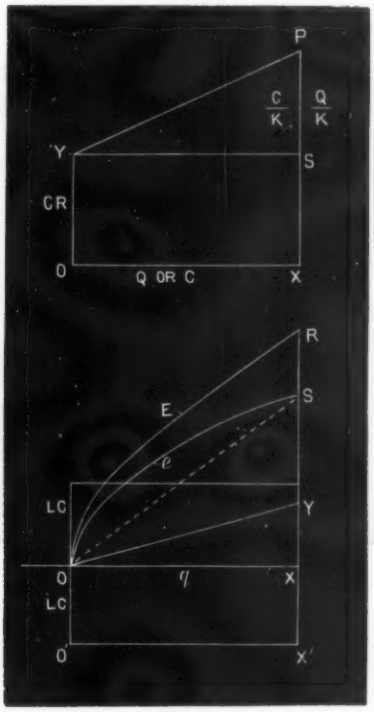


FIG. 4.

In the diagram, fig. 4, the curve O e S represents the relation of e and q, it is a parabola as shown by equation (2), the straight line, O Y, represents the relation of the back E.M.F. to q and the curve O E R, the ordinates of which are the sum of those of O Y, and O e S represents the relation of the impressed E.M.F. to q. Area O E R X represents total energy expended in one second, area O e S X represent heat energy expended in one second, and the difference of these areas or area, O Y X, represents energy stored in the condenser in one second. If K be taken so that X Y = X S or $1 = K R \sqrt{2}$, then by a property of the parabola the area O S X $= \frac{3}{4}$ of area, O e S X, so that the energy stored is $\frac{3}{4}$ of the heat energy, or $\frac{3}{7}$ths of the total energy supplied. If we take self-induction into account we must use the equation

$$E = t C R + L \frac{d(t C)}{d t} + \frac{q}{K} = t C R + L C + \frac{q}{K}$$

or putting in t in terms of q

$$E = R \sqrt{2 q C} + L C + \frac{q}{K}.$$

This curve, O' O E R X', is plotted with O' X' as the axis of X, O O' being $= L C$. The area, O O' X X', represents energy stored in the dielectric. As an example, take K and L so that $1 = K R \sqrt{2} = 2 K L$, then the energy stored in the dielectric $= L C \times q$ will be equal to the energy stored in the condenser $= \frac{1}{2} q^2 K$, and the energy stored in the condenser will be $\frac{3}{4}$ of the heat waste, so that of the total energy supplied 30 per cent. will be stored in the condenser, 30 per cent. in the dielectric, and 40 per cent. wasted in heat in the circuit.

IS THE EARTH A RESERVOIR OF ELECTRICITY?

[By SYDNEY F. WALKER.

Notwithstanding the advances which have been made in the knowledge of the principles of electrical science, it is still not uncommon to find writers upon electrical subjects, particularly those who write for the non-electrical public, giving the old statement which used to be given in text books of 20 years ago, that the earth may be considered to be an infinite reservoir of electricity. Even so able a writer as Prof. Garnett of the Durham College of Science, in a recent paper read before the North of England Mining Institute, advised members to consider that you may take out as much electricity as you please from the earth at any particular point, and return it to the earth again at any other point. Mr. Segundo also, in his little *brochure* on "Domestic Electric Lighting" recently issued, gives the same advice, and in addition, tells his readers that the quantity of electricity present in the earth and its surroundings is fixed. You cannot increase the quantity, nor can you decrease it.

In the writer's opinion, both of these views, though evidently given with the idea of simplifying the matter to those who have not had the opportunity of studying the question for themselves, are apt to be misleading. The earth is in no sense a reservoir of electricity. Nor can we be sure of taking an infinite quantity of electrical energy from the earth at any point, nor of passing it into the earth at any other point. We can only perform an operation which looks like this, when the electrical resistance of the intervening portion of the earth's crust, that lying between the two points, is sufficiently small to allow of the passage of a current of infinite strength. In rocky districts, for instance, where minerals are not present, the current which we can hope to get through any circuit of which the rocky portion of the earth's crust in the neighbourhood forms a part, is very small indeed, no matter how large the earth plates may be. In some districts it is found impracticable to get earth at all, even for the small currents used for telegraphic purposes. The earth, in fact, can only act as a conductor, and exactly as any other conductor. That is to say, the current which can be passed through any portion of its crust must be strictly in proportion to its dimensions, and to the specific resistance of the materials which lie in the path taken by the current.

It should be noted, of course, that these dimensions are not confined to the sectional area contained between the earth plates, or whatever the arrangement for making connection to earth may be. Currents will pass by every path that is open between the two earth connections, and these paths may extend in every direction round the direct path between the two connections to earth; but as the length of each of these paths becomes longer and longer, as their position becomes farther and farther from the direct path referred to, their resistance becomes larger and larger, provided the substances passed through are the same; so that for the practical purpose of conducting any given current, a limit is soon reached beyond which the outer paths do not appreciably affect the actual resistance offered to conduction, the resistance the engineer has to deal with.

The distance which these additional paths extend will, of course, vary with the conditions present, such as the size of the earth plates, the E.M.F. present between the earth connections, and the character of the substances forming the earth's crust at that particular place. The presence also of any other conductor, such as a body of water, a mineral vein, or another external conductor connected to earth at other points which lie in the path of the current, will considerably modify the path or paths taken by the latter. Thus, if in its passage from one earth connection to the other, the earth connection of another wire is encountered, a portion of the current will undoubtedly follow that wire to its destination, and return to its own earth connection by any other path that is open to it. But in all these cases, it is electrical conduction which is taking place, not a simple discharge in one place, and a re-demand in another.

So, too, it appears to the writer to be incorrect to say that the quantity of electricity present in the earth and its surroundings is fixed.

The quantity of energy is fixed, and the quantity of matter is fixed. You cannot create or destroy either energy or matter, you can only transform them. But this is going on constantly. The available quantity of heat is being constantly drawn upon for transformation into sound, light, electricity and magnetism, and is being as constantly added to by transformations from those sources of energy. So that it may very possibly happen that the quantity of electrical energy present at any moment in the earth and its surroundings is much more than at another moment. We have numerous instances of this in our midst. The quantity of electrical energy distributed from a large electric lighting station is very much larger during the busy evening hours than at any other period of the day. But this increased quantity has not been taken from any store except, of course, where accumulators are used, and then not in the sense that would be indicated if we look upon the earth as a reservoir. As is well known, in these cases the supply has not come from the earth in any sense. The conductors have been rigidly protected, if the installation has been properly laid out and kept in order, from any but a leakage connection with earth at all, and that is made as small as funds will allow. The electrical energy distributed from electric lighting stations has been obtained, by several transformations, from the heat energy stored in the coal by the action of the Sun during past ages, and is obtained by the combination of its elements with the oxygen of the atmosphere. It appears to the writer that the error arises from the attempt to follow too closely the analogy of water. There is a cycle of operations going on by means of which water is constantly passing and repassing from the earth, the oceans, rivers, &c., to the clouds, and back to the earth, rivers and oceans in the form of rain. And the immense body of water always present in and on the earth's crust may be looked upon as a practically infinite reservoir, from which the wants of man and the earth generally are supplied. But it is not correct to say even that the quantity of water present in and about the earth is constant. Heat, and electrical and electro-chemical actions are constantly going on, which transform what was water into other substances, and other similar actions are as constantly transforming portions of other substances into water. Possibly the average quantity present at various times may be about the same. But this is a very different thing from the absolute law which rules with matter and with energy.

Further, it must be remenbered that even the laws of the conservation of energy apply to the whole universe, not to that small portion only which we inhabit. Meteoric dust is constantly adding to the mass of the earth's crust; and, on the other hand, the earth is constantly radiating a portion of its heat into space, and so losing, so far as the earth is concerned, a portion of the energy stored in its interior. Yet, again, we are constantly receiving energy in the form of heat from our sun, moon, planets, and the other celestial bodies, so that a constant exchange both of matter and energy is going on every minute of our existence, maintaining, by the wonderful balance always preserved by nature's laws, those conditions most suitable to our well being, with the exception of those occasional times of variation which give rise to such terrible results in the form of earthquakes, hurricanes, &c.

The writer is fully cognisant of the difficulties which meet one when attempting to give those who have not studied electrical science some idea to work upon, which will enable them to follow the action of the electric current through the various phenomena which it produces; and he quite appreciates the temptation to give a simple analogy. But he has always regarded it as a dangerous plan to allow the analogy to be at all erroneous. If men study the matter at all, they will think a little deeper, and then the erroneous analogy confuses them, while it is not usually difficult for them to grasp the idea of a transference of energy from one form to another. Those who are likely to take the question up at all see this every time a bearing gets warm, if they will stop to think it out. To those who will not think a little deeper with the view of getting a sound basis for their studies, analogies are useless, however simple.

ALTERNATING CURRENTS AND THE E.M.F. QUANTITY DIAGRAM.

BY ARTHUR WHITWELL, M.A., A.R.C.Sc.

THE object of this paper is to illustrate an easy method of dealing with problems in which the currents or E.M.Fs. considered are variable, and to point out some of the properties of, and to show how to plot the E.M.F. quantity diagram. For the sake of illustration several cases will be dealt with in which an E.M.F., constant or varying according to some known law, is impressed in a circuit containing a condenser in series or forming a shunt.

First.—Let a constant E.M.F., E, be impressed in a circuit of resistance, R, having a condenser of capacity K in series (see fig. 1). If q be the quantity of electricity in the condenser at any instant $\frac{q}{K}$ will be the difference of potential of its terminals or the back E.M.F. The effective E.M.F. will be $E - \frac{q}{K}$, and a current will flow until $E - \frac{q}{K} = 0$; let q then be $= Q$. Draw a rectangle, O X P V, fig. 2, making the side, O V, represent E or $\frac{Q}{K}$, and the side, O X, represent Q, and join O P. The area of the rectangle then represents the whole energy expended and the area of the triangle, O X P, represents the energy stored in the condenser, for it is equal to $\frac{1}{2}$ O X . X P, that is to half the product of the quantity in the condenser and the difference of potential of its terminals. Therefore if we charge a condenser with a constant E.M.F., only half the total energy expended is stored in the condenser, the other half being expended in the circuit in the form of heat. If the circuit be supposed to have self induction the result would be the same, for if the condenser be discharged the whole of its energy would disappear as heat, and as the current goes through the same phases in charging as in discharging, except that they are reversed, the same amount of energy is expended in the form of heat in each case, that is, one-half the total energy expended in charging.

FIG. 1.

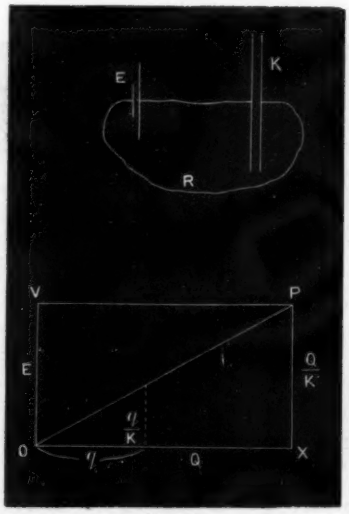


FIG. 2.

Secondly.—If the condenser be charged with a constant current C, we have the impressed E.M.F. $= C R + \frac{q}{K}$. Let Q now represent the quantity put into the condenser in unit time, then in the diagram, fig. 3, if O Y represent C R and X P, $C R + \frac{Q}{K}$ the area, O X P Y will represent the total energy expended, and the area of the triangle, P Y S, will represent the energy stored in the condenser in unit of time. If $C R = \frac{Q}{K}$ or $R = \frac{1}{K}$ the area of the triangle will be one-third of the whole figure, or the energy stored in the condenser is one-third of the total supplied.

Thirdly.—Let us take the case of a charging current uniformly increasing with the time. Call it $t C$. The quantity in the condenser at any instant will be $= q =$ average current $\times$ time $= \frac{t C}{2} \cdot t = \frac{t^2 C}{2}$ the back E.M.F will be $= \frac{q}{K} = \frac{t^2 C}{2 K}$, and the impressed E.M.F. $= t C R + \frac{t^2 C}{2 K} = R \sqrt{2 q C} + \frac{q}{K}$. Calling the impressed and effective E.M.Fs., E and e respectively we have—

$$\left(E - \frac{q}{K}\right)^2 = 2 R^2 q C \qquad (1)$$

$$e^2 = 2 R^2 q C. \qquad (2)$$

FIG. 3.

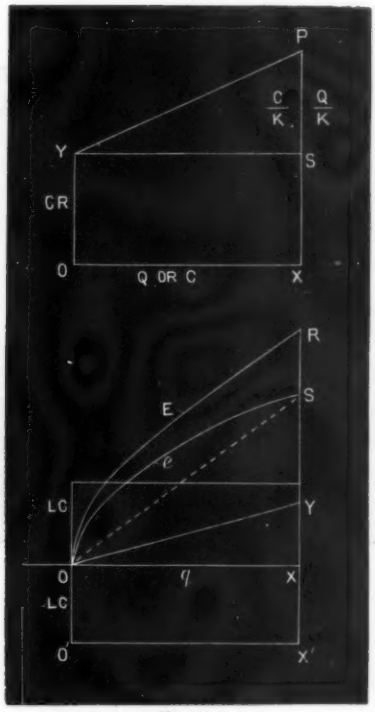


FIG. 4.

In the diagram, fig. 4, the curve O e S represents the relation of e and q, it is a parabola as shown by equation (2), the straight line, O Y, represents the relation of the back E.M.F. to q and the curve O E R, the ordinates of which are the sum of those of O Y, and O e S represents the relation of the impressed E.M.F. to q. Area O E R X represents total energy expended in one second, area O e S X represent heat energy expended in one second, and the difference of these areas or area, O Y X, represents energy stored in the condenser in one second. If K be taken so that X Y = X S or $1 = K R \sqrt{2}$, then by a property of the parabola the area O S X = $\frac{3}{4}$ of area, O e S X, so that the energy stored is $\frac{3}{4}$ of the heat energy, or $\frac{3}{7}$ths of the total energy supplied. If we take self-induction into account we must use the equation

$$E = t C R + L \frac{d(t C)}{d t} + \frac{q}{K} = t C R + L C + \frac{q}{K}$$

or putting in t in terms of q

$$E = R \sqrt{2 q C} + L C + \frac{q}{K}.$$

This curve, O′ O E R X′, is plotted with O′ X′ as the axis of X, O O′ being $= L C$. The area, O O′ X X′, represents energy stored in the dielectric. As an example, take K and L so that $1 = K R \sqrt{2} = 2 K L$, then the energy stored in the dielectric $= L C \times q$ will be equal to the energy stored in the condenser $= \frac{1}{2} q^2 K$, and the energy stored in the condenser will be $\frac{3}{4}$ of the heat waste, so that of the total energy supplied 30 per cent. will be stored in the condenser, 30 per cent. in the dielectric, and 40 per cent. wasted in heat in the circuit.

Fourthly.—Let the charging current vary according to a sine law and be $= C \sin p t$, where C is the maximum value and $p = \frac{2\pi}{T}$, T being the time of a complete period $\sim$. The average value of $\sin\theta$ between the values θ_1 and θ_2 is $\frac{\cos\theta_2 - \cos\theta_1}{\theta_1 - \theta_2}$; or if $\theta_2 = 0$ $\frac{1 - \cos\theta_1}{\theta_1}$. So that the average value of $C \sin p t$, up to a time $t = \frac{C(1 - \cos p t)}{p t}$ and $\therefore q$ = average current × time $= \frac{C}{p}(1 - \cos p t)$. The effective E.M.F. $e = C R \sin p t$. Eliminating t from these two equations we get

$$q^2 - 2q\frac{C}{p} + \frac{e^2}{p^2 R^2} = 0.$$

This equation represents the ellipse, *e* (fig. 5), of which

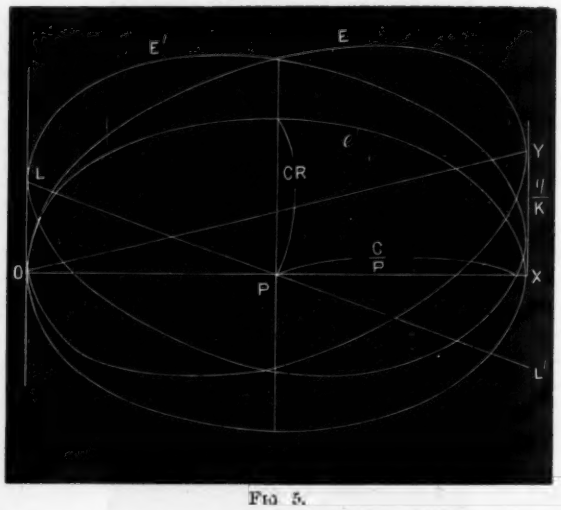


FIG. 5.

the semi-major axis is $\frac{e}{p}$ and the semi-minor C R. Make X Y at 90° to O X, and $= \frac{2e}{p K}$ and join O Y. The straight line O Y represents the relation of $\frac{q}{K}$ to q, or the back E.M.F. due to the condenser. The curve, E, the ordinates of which are the algebraic sum of those of the curve, *e* and the straight line O Y, represents the relation of the impressed E.M.F to q. It is an ellipse, as seen by its equation,

$$E = C R \sin p t \times \frac{q}{K},$$

when we put in q in terms of t, viz.,

$$q^2\left(\frac{1}{K^2} + p^2 R^2\right) - \frac{2Eq}{K} - 2CR^2 p q + E^2 = 0,$$

and is equal in area to the ellipse, *e*.

The area of the ellipse, *e*, represents energy spent in heat in one cycle and = π × product of semi axes $= \pi C R \times \frac{C}{p} = \frac{C^2 R T}{2}$. The area of the ellipse, E, represents total energy supplied in one cycle, and $= \frac{C^2 R T}{2}$. The area, O Y X, represents energy stored in the condenser in one half of the period and given out again in the other half. In the first half period the ratio of the energy stored to the energy spent in heat is as

$$\frac{2C^2}{p^2 K} : \frac{C^2 R T}{4} = \frac{2T}{\pi^2 K R} : 1.$$

If we take self-induction into account the impressed

$$\text{E.M.F.} = C R \sin p t + \frac{q}{K} + L\frac{d(C \sin p t)}{dt}$$

$$= C R \sin p t + \frac{q}{K} + L C p \cos p t.$$

The term $L C p \cos p t$ may be written

$$L C p\left(1 - \frac{p q}{C}\right) = L C p - L p^2 q,$$

and may be expressed on the diagram by the straight line, L L¹, O L being $= L C p$ and X L¹ $= -L C p$. The impressed E.M.F. — quantity curve, E, is found by adding the ordinates of the curve, *e*, and the two straight lines, O Y and L L¹. It will be found to be an ellipse equal in area to the others. The area, L O P or L¹ P X, represents energy stored in the dielectric in the first and third quarters of the period and given out again in the second and fourth.

Fifthly.—Let the impressed E.M.F. vary according to a sine law, and the condenser shunt a portion of the circuit as shown in fig. 6. Let the resistance of the right portion of the circuit be R, that of the left, r, the capacity of the condenser, K, and let us *assume* that an E.M.F. impressed at E by a generator, will produce at current of C sin $p t$, is the R portion of the circuit. If q be the quantity in the condenser

FIG. 6.

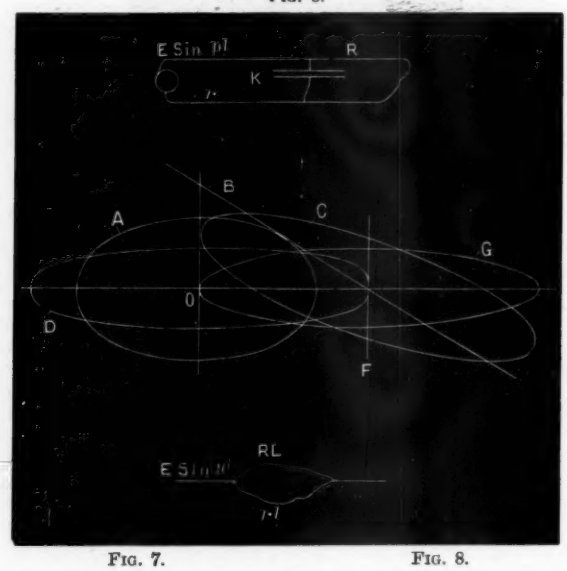


FIG. 7. FIG. 8.

at any instant the difference of potential of its terminals will be $\frac{q}{K} = C R \sin p t$ $\therefore q = C K R \sin p t$. The current entering the condenser is $\frac{dq}{dt}$ and $= p C K R \cos p t$, and the current in the r branch of the circuit being equal to the sum of the other two

$$= C \sin p t + p C K R \cos p t$$

$$= C(\sin p t + p K R \cos p t)$$

$$= C\sqrt{1 + p^2 K^2 R^2}\sin(p t + \phi)$$

where $\tan\phi = p K R$

$$\sin\phi = \frac{p K R}{\sqrt{1 + p^2 K^2 R^2}}$$

$$\cos\phi = \frac{1}{\sqrt{1 + p^2 K^2 R^2}}$$

The E.M.F. impressed at E will be = effective E.M.F. + back E.M.F. of condenser.

$$= r C\sqrt{1 + p^2 K^2 R^2}\sin(p t + \phi) + R C \sin p t$$

$$= C(r\sqrt{1 + p^2 K^2 R^2}\sin(p t + \phi) + R \sin p t)$$

Expanding $\sin(p t + \phi)$ and substituting values of $\sin\phi$ and $\cos\phi$, we get

$$= C((R + r)\sin p t + r p K R \cos p t)$$

$$= C\sqrt{(R + r)^2 + (r p K R)^2}\sin(p t + \theta)$$

where $\tan\theta = \frac{r p K R}{r + R}$.

Thus an impressed E.M.F. of $C\sqrt{(R + r)^2 + (r p K R)^2}$ $\sin(p t + \theta)$ at E, will give a current of $C\sqrt{1 + p^2 K^2 R^2}$

$\sin(p\,t+\phi)$ in r, and a current of $C \sin p\,t$ in R. By making $C\sqrt{(R+r)^2+(r\,p\,K\,R)^2} = E$, and $p\,t+\theta = p\,t^1$, we see that an impressed E.M.F. of $E \sin p\,t^1$, gives a current of $\frac{E\sqrt{1+p^2K^2R^2}}{\sqrt{(R+r)^2+(p\,K\,R\,r)^2}}\sin(p\,t^1-(\theta-\phi))$ in r, and a current of $\frac{E}{\sqrt{(R+r)^2+(p\,K\,R\,r)^2}}\sin(p\,t^1-\theta)$ in R.

The current in r lags behind the impressed E.M.F. by an angle $(\theta-\phi)$, or the current reaches its maximum, $\frac{\theta-\phi}{2\pi}$ T seconds after the E.M.F. The current in R lags behind the impressed E.M.F. by an angle, θ, or time $\frac{\theta}{2\pi}$ T seconds. The difference of phase of the currents in r and R is ϕ, that is, the current in r attains its maximum $\frac{\phi}{2\pi}$ T seconds before that in R. We can express the energy expended in the various parts of the circuit, as before, by E.M.F. quantity curves. (1) The total energy expended may be represented by the area of a curve formed by plotting as ordinates the impressed E.M.F. and as abscissæ the quantity of electricity that has passed any section of the r portion of the circuit from the time at which the current was zero up to the time considered. (2.) The energy expended in the r portion may be expressed by the area of the effective E.M.F. quantity curve, and (3), the energy expended in heat in the R portion may be expressed by the area of the effective E.M.F. quantity curve in that portion.

(1.) The impressed E.M.F. is $E \sin p\,t$ and the current is

$$\frac{E\sqrt{1+p^2K^2R^2}}{\sqrt{(R+r)^2+(p\,K\,R\,r)^2}}\sin(p\,t-(\theta-\phi)$$

To save space assume them to be $E \sin p\,t$, and $C \sin(p\,t-\psi)$. As before we get

$$\left.\begin{aligned} q &= \frac{C}{p}(1-\cos(p\,t-\psi)\\ e &= E \sin p\,t \end{aligned}\right\}$$

Eliminating t we get

$$q = \frac{C}{p} - \frac{C}{p}\frac{e}{E}\sin\psi \pm \frac{C}{p}\cos\psi\sqrt{1-\frac{e^2}{E^2}}$$

This curve can be plotted in two parts, taking the last term

$$q = \pm\frac{C}{p}\cos\psi\sqrt{1-\frac{e^2}{E^2}}$$

can be written

$$\frac{q^2}{\frac{C^2\cos^2\psi}{p^2}} + \frac{e^2}{E^2} = 1$$

and represents the ellipse A, fig. 7, the semi-major axis being $\frac{C\cos\psi}{p}$ and the semi-minor E. Taking the other two terms

$$q = \frac{C}{p} - \frac{C}{p}\frac{e}{E}\sin\psi$$

this represents the straight line B, the intercepts on the axes of X and Y being $\frac{c}{p}$ and $\frac{E}{\sin\psi}$ respectively. By adding the abscissæ of A and B we get the curve C, which is the impressed E.M.F. quantity curve required. It is an ellipse equal in area to the ellipse A. The straight line, B, is tangent to the ellipse A at a point where $e = E \sin\psi$. The areas of the ellipses, A and C, being equal the total energy expended is a period

$$= \pi \times \text{product of semi axes of A}$$
$$= \pi\frac{C}{p}\cos\psi\,E = \frac{T\,E\,C\cos\psi}{2},$$

or putting in the values of C and $\cos\psi$

$$= \frac{T\,E^2}{2}\cdot\frac{R+r+r\,p^2K^2R^2}{(R+r)^2+(p\,K\,R\,r)^2}.$$

(2.) The energy expended in heat per $\sim$ in the r portion of the circuit. The current

$$= \frac{E\sqrt{1+p^2K^2R^2}}{\sqrt{(R+r)^2+(p\,K\,R\,r)^2}}\sin(p\,t-(\theta-\phi))$$

and the effective E.M.F. $= r$ times this current. Write them for brevity $C \sin(p\,t-\psi)$ and $C\,r \sin(p\,t-\psi)$. As before, $q = \frac{C}{p}\{1-\cos(p\,t-\psi)\}$; $e = C\,r\sin(p\,t-\psi)$, and by eliminating t we get

$$q = \frac{C}{p} \pm \frac{C}{p}\sqrt{1-\frac{e^2}{C^2r^2}}.$$

Plotting in two parts, as before, the first term represents the straight line F, fig. 7, and the second term the ellipse, D, the semi axes being $\frac{C}{p}$ and $C\,r$. By adding the abscissæ we get the ellipse, G, equal in area to D, which is the effective E.M.F. quantity curve. The area of the ellipse, D or G, represents the heat energy per $\sim$ in the r portion, and $= \pi\frac{C^2\,r}{p}$, or putting in the values of C and p, $= \frac{T\,E^2}{2}\times\frac{r+r\,p^2K^2R^2}{(R+r)^2+(p\,K\,R\,r)^2}$. The difference of the areas of C and G will be the heat expenditure per cycle in the R portion, and will be

$$= \frac{T\,E^2}{2}\times\frac{R}{(R+r)^2+(p\,K\,R\,r^2)^2}.$$

We might plot another ellipse to represent it. The total energy expended is therefore divided between the r and R portions in the ratio of $\frac{r(1+p^2K^2R^2)}{R}$. If K became 0, or if no condenser was in circuit, this ratio would be $\frac{r}{R}$, the energy expended in the r portion would be

$$\frac{T\,E^2}{2}\cdot\frac{r}{(R+r)^2},$$

than in the R portion $\frac{T\,E^2}{2}\cdot\frac{R}{(R+r)^2}$,

and the total energy would be $\frac{T\,E^2}{2}\times\frac{1}{R+r}$. It will be seen that the effect of the condenser is to increase the total energy expended, and the part expended in the r portion, and to diminish the energy expended in the R portion. The energies being expressed as the areas of ellipses, we can find the conditions under which they will be maxima by making the semi-axes of the various ellipses equal. The total energy is a maximum when $\cos\psi = 1$, that in the r portion when $p\,r = 1$, that is the R portion when $p\,R = 1$.

In this last investigation we have supposed the circuit to be inductionless; let us now take self-induction into account, and call the induction of the R portion L, and that of the r portion L^1. Again, suppose a certain impressed E.M F. at E, fig. 7, to give a *current* of $C \sin p\,t$ in the R branch. The difference of potential at the terminals of the condenser will be $\left(\text{from the equation } E = C\,R + L\frac{d\,C}{d\,t}\right)$

$$= C\,R\sin p\,t + L\,p\,C\cos p\,t$$
$$= C(R\sin p\,t + L\,p\cos p\,t)$$
$$= C\,a\sin(p\,t+\theta)$$

where $\tan\theta = \frac{L\,p}{R}$

and $a = \sqrt{R^2+L^2p^2}$

If q be the quantity in the condenser at any instant, we have $\frac{q}{K} = C\,a\sin(p\,t+\theta)$ or $q = C\,a\,K\sin(p\,t+\theta)$ and the current entering the condenser at that instant $= \frac{d\,q}{d\,t} = p\,K\,C\,a\cos(p\,t+\theta)$. The current in the r branch will be the sum of the current entering the condenser and that is the R branch and will be $= C\sin p\,t + p\,K\,C\,a\cos(p\,t+\theta)$. Expanding $\cos(p\,t+\theta)$ we get

Current in r branch $= C\{(1-L\,p^2K)\sin p\,t + p\,K\,R\cos p\,t\}$

or if $\tan\phi = \frac{p\,K\,R}{1-L\,p^2\,K}$ and $\beta = \sqrt{(1-L\,p^2K)^2+(p\,K\,R)^2}$

$$= C\,\beta\sin(p\,t+\phi)$$

The E.M.F impressed at E = effective E.M.F. producing current in r + back E.M.F. due to condenser + back E.M.F. of self-induction = $r\,C\,\beta \sin(pt+\phi) + C\,\alpha \sin(pt+\theta) + L'\,p\,C\,\beta \cos(pt+\phi)$; expanding and collecting coefficients we get $= C\,(B \sin pt + A \cos pt)$ where $A = pKRr + L'p(1 - Lp^2K) + Lp$, and $B = r(1 - Lp^2K) - L'p^2KR + R$, or impressed E.M.F. $= C\sqrt{A^2+B^2} \sin(pt+\psi)$ where $\tan\psi = \frac{A}{B}$. Thus we see that an impressed E.M.F. of $C\sqrt{A^2+B^2}\sin(pt+\psi)$ at E will give a current of $C\beta\sin(pt+\phi)$ in the r branch and a current of $C\sin pt$ in the R branch. By making $C\sqrt{A^2+B^2} = E$ and $pt' = pt + \psi$ we find that an impressed E.M.F. of $E\sin pt'$ in the r branch will give a current of $\frac{E\beta}{\sqrt{A^2+B^2}}\sin(pt'-(\psi-\phi))$ in that branch, and a current of $\frac{E}{\sqrt{A^2+B^2}}\sin(pt'-\psi)$ in the R branch. The current in the R branch lags behind that in r by an angle ϕ and behind the impressed E.M.F. by an angle, ψ. To find the total energy we must plot the impressed E.M.F. and quantity curve for the r branch, we have

$$e = E\sin pt$$

$$C = \frac{E\beta}{\sqrt{A^2+B^2}}\sin(pt-(\psi-\phi))$$

Writing this last equation $= C\sin(pt-\omega)$, we get

$$q = \frac{C}{p} \pm \frac{C}{p}\cos\omega\sqrt{1-\frac{e^2}{E^2}} - \frac{C}{p}\frac{e}{E}\sin\omega,$$

and the semi-axes of the ellipse, A, fig. 7, are now $\frac{C}{p}\cos\omega$ and E, and the intercepts of the straight line, B, on the axis of X and Y respectively are $\frac{C}{p}$ and $\frac{E}{\sin\omega}$. The area of each ellipse, A and C, or the total energy expended is $\pi\frac{CE}{p}\cos\omega$, or putting in values of C and $\cos\omega$ and p

$$= \frac{TE^2}{2} \times \frac{B(1-Lp^2K) + Ap KR}{A^2+B^2}$$

The heat expenditure in the r portion is expressed by the ellipse D or G, the semi axes of which are $\frac{C}{p}$ and $C\,r$ as before, and the area or heat energy

$$= \pi\frac{C}{p}C\,r = \frac{TE^2}{2}\cdot\frac{r\{(1-Lp^2K)^2 + (pKR)^2\}}{A^2+B^2}$$

The heat expenditure in the R portion is expressed by the difference of the areas of ellipses A and D or C and G, or by the area of the effective E.M.F. quantity curve for that branch, and is found to be

$$= \frac{TE^2}{2}\cdot\frac{R}{A^2+B^2}.$$

Without a condenser or making $K = 0$, the total energy expended in a period $\sim$ is

$$\frac{TE^2}{2}\cdot\frac{R+r}{(R+r)^2 + p^2(L+L^1)^2}$$

The portion expended in the r branch is

$$\frac{TE^2}{2}\cdot\frac{r}{(R+r)^2 + p^2(L+L^1)^2}$$

The portion expended in the R branch is

$$\frac{TE^2}{2}\cdot\frac{R}{(R+r)^2 + p^2(L+L^1)^2}$$

With a condenser

$$\frac{\text{Energy expended in } r \text{ branch}}{\text{Energy expended in R branch}} = \frac{r}{R}\{(1-Lp^2K)^2 + (pKR)^2\}$$

Without a condenser

$$\frac{\text{Energy expended in } r \text{ branch}}{\text{Energy expended in R branch}} = \frac{r}{R}$$

The effect of the condenser, then, is to increase the total energy expended but to diminish the portions expended in the R branch.

Lastly.—We can use this method of working to determine the equivalent resistance and inductance of a divided circuit in one branch of which an alternating E.M.F. is impressed. Let R L and r l, fig. 8, be the resistances and inductances of the two branches, and let an E.M.F. of $E\sin pt$ be impressed. By assuming a current of $C\sin pt$ in the R branch, we find that the impressed E.M.F. would be $= CR\sin pt + LCp\cos pt = C\sqrt{R^2+p^2L^2}\sin(pt+\theta)$ where $\tan\theta = \frac{pL}{R}$. We can conclude, therefore, as before, that an impressed E.M.F. of $E\sin pt$ would give a current in the R branch

$$= \frac{E}{\sqrt{R^2+p^2L^2}}\sin(pt-\theta)$$

and a current in the r branch

$$= \frac{E}{\sqrt{r^2+p^2l^2}}\sin(pt-\phi),$$

where $\tan\phi = \frac{pl}{r}$.

Let $\alpha = \sqrt{R^2+p^2L^2}$ and $\beta = \sqrt{r^2+p^2l^2}$.

The total current will be

$$= \frac{E}{\alpha}\left(\sin pt\,\frac{R}{\alpha} - \cos pt\,\frac{pl}{\alpha}\right) + \frac{E}{\beta}\left(\sin pt\,\frac{r}{\beta} - \cos pt\,\frac{pl}{\beta}\right)$$

$$= E\left\{\sin pt\left(\frac{R}{\alpha^2}+\frac{r}{\beta^2}\right) - \cos pt\left(\frac{pL}{\alpha^2}+\frac{pl}{\beta^2}\right)\right\}$$

$$= E\sqrt{\left(\frac{R}{\alpha^2}+\frac{r}{\beta^2}\right)^2 + \left(\frac{pL}{\alpha^2}+\frac{pl}{\beta^2}\right)^2}\sin(pt-\omega) \quad (1)$$

where

$$\tan\omega = \frac{\frac{pL}{\alpha^2}+\frac{pl}{\beta^2}}{\frac{R}{\alpha^2}+\frac{r}{\beta^2}}$$

Now if we call R^1 the equivalent resistance, and L^1 the equivalent inductance of the divided circuit, the total current would be

$$= \frac{E}{\sqrt{R^{12}+p^2L^{12}}}\sin(pt-\psi) \quad (2) \text{ where } \tan\psi = \frac{pL^1}{R^1}$$

We can transform (1) as follows:—

$$C = \frac{E}{\sqrt{\left\{\left(\frac{R}{\alpha^2}+\frac{r}{\beta^2}\right)^2 + \left(\frac{pL}{\alpha^2}+\frac{pl}{\beta^2}\right)^2\right\}^2 + \left\{\frac{p^2\left(\frac{L}{\alpha^2}+\frac{l}{\beta^2}\right)^2}{\left(\frac{R}{\alpha^2}+\frac{r}{\beta^2}\right)^2 + \left(\frac{pL}{\alpha^2}+\frac{pl}{\beta^2}\right)^2}\right\}^2}}$$

$$(\sin pt - \omega).$$

Comparing this with (2) we see that

$$R^1 = \frac{\frac{R}{\alpha^2}+\frac{r}{\beta^2}}{\left(\frac{R}{\alpha^2}+\frac{r}{\beta^2}\right)^2 + \left(\frac{pL}{\alpha^2}+\frac{pl}{\beta^2}\right)^2}$$

and

$$L^1 = \frac{\frac{L}{\alpha^2}+\frac{l}{\beta^2}}{\left(\frac{R}{\alpha^2}+\frac{r}{\beta^2}\right)^2 + \left(\frac{pL}{\alpha^2}+\frac{pl}{\beta^2}\right)^2}$$

or if $A = \Sigma\frac{R}{R^2+p^2L^2}$ and $B = \Sigma\frac{L}{R^2+p^2L^2}$

$$R^1 = \frac{A}{A^2+p^2B^2} \text{ and } L^1 = \frac{B}{A^2+p^2B^2}$$

The equivalent impedance would be

$$\sqrt{\frac{A^2}{(A^2+p^2B^2)^2} + p^2\frac{B^2}{(A^2+p^2B^2)^2}}$$

In conclusion, the method adopted in this paper has been one of "working backwards." It will be seen that, given an impressed E.M.F. and requiring a current, we have assumed a current, easily found the corresponding impressed E.M.F., and then, by a suitable substitution, made this E.M.F. correspond to the given E.M.F., and by the same substitution in the assumed current have found the required current; by this method, which only requires a little trigonometry, we have obviated the necessity of solving tedious and disagreeable differential equations, and have arrived at absolutely correct results, if we except a term which relates only to the first few periods, and which can always be neglected.

PATENT LAW FOR THE PORTUGUESE COLONIES.

THE efficacy of the present Portuguese Patent Law of March 22nd, 1868, was subsequently extended to the trans-marine provinces, viz., the Cape Verde Islands, St. Thomas and Principe, Angola, Benguela, Mozambique, Goa, and Diu. It varies, in some respects, from the patent law system of the mother country.

The law distinguishes between patents for invention and patents for introduction, a distinction not made in the Portuguese law.

The duration of patents for inventions is 20 years, if the invention is carried ont in the trans-marine territories, and with their productions. In Portugal itself, protection is available for, at most, 15 years, and patents for inventions already in use in foreign countries expire with the lapse of the first patent.

If the holder of a patent for the introduction of an invention does not show within two years that the process is really in use and execution, the patent is at once annulled. The following determinations are in force for all patents :—

The rights of the patentee are assignable, and in the absence of any determination to the contrary, they are dealt with according to the laws concerning movable property.

The patentee has a claim for damages in case of infringement.

Each patent must include only one subject.

No official examination of an application for a patent will take place, and the Government does not guarantee the novelty or the patentability of the invention.

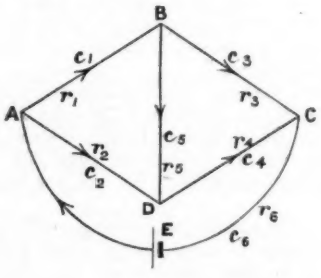
A patent is granted 30 days after the application.

Within a year no one, save the original inventor, may apply for an addition to a patent. An improvement on, or an addition to, a patent cannot be put in practice without the consent of the original patentee. Nor can such original patentee use such improvement without the consent of the second patentee.

NOTE ON THE WHEATSTONE BRIDGE.

BY ARTHUR WHITWELL, M.A.

THE usual way of finding the currents in the six conductors joining four points when given the resistance of each branch, and the E.M.F. impressed in one or more branches is to solve six simultaneous equations written down by using Kirchoff's two laws. This process is laborious.



By the following method the equations may be reduced to two. Let $r_1 \ldots r_6$ be the resistances, $c_1 \ldots c_6$ the currents, E the E.M.F. impressed in branch 6, and A, B, C, D, the potentials of those four points. Then we have

$$A - B = c_1 r_1 \quad (1)$$

$$A - D = c_2 r_2 \quad (2)$$

From (1) and (2) $B - D = c_2 r_2 - c_1 r_1$

$$\therefore c_5 = \frac{c_2 r_2 - c_1 r_1}{r_5}$$

Now $$c_3 = c_1 - c_5 = c_1 - \frac{c_2 r_2 - c_1 r_1}{r_5}$$

and $$c_4 = c_2 + c_5 = c_2 + \frac{c_2 r_2 - c_1 r_1}{r_5}$$

$$\therefore B - C = c_3 r_3 = r_3 \left(c_1 - \frac{c_2 r_2 - c_1 r_1}{r_5} \right) \quad (3)$$

and $$D - C = c_4 r_4 = r_4 \left(c_1 - \frac{c_2 r_2 - c_1 r_1}{r_5} \right). \quad (4)$$

Adding 1 and 3, and 2 and 4, we get

$$A - C = c_1 r_1 + r_3 \left(c_1 - \frac{c_2 r_2 - c_1 r_1}{r_5} \right) \quad (5)$$

$$A - C = c_2 r_2 + r_4 \left(c_1 - \frac{c_2 r_2 - c_1 r_1}{r_5} \right) \quad (6)$$

The E.M.F., E, in the branch 6 has to drive the current $c_6 = c_1 + c_2$ through the resistance r_6, and to maintain the difference of potential between A and C.

$$\therefore E = (c_1 + c_2) r_6 + c_1 r_1 + r_3 \left(c_1 - \frac{c_2 r_2 - c_1 r_1}{r_5} \right) \text{ from 5.}$$

$$E = (c_1 + c_2) r_6 + c_2 r_2 + r_4 \left(c_1 - \frac{c_2 r_2 - c_1 r_1}{r_5} \right) \text{ from 6.}$$

From these two equations, c_1 and c_2, can be found in terms of E, and the six resistances, c_1 and c_2, being found, $c_3 \ldots c_6$ are readily obtained from the other equations.

SOME CURIOSITIES IN EARLY ELECTRO-THERAPEUTICS.*

BY PROF. EDWIN J. HOUSTON.

THE astonishing physical effects produced by the discharge of the Leyden jar through the human body, led not only the general public, but also the medical fraternity, shortly after its discovery in 1745, to form the most absurd ideas concerning the curative powers of electricity.

The wildest claims were made concerning the efficacy of the electric discharge for the curing of disease. Claims that were at first unhesitatingly accepted as true, were soon found, in actual practice, to fail of realisation.

That *bonâ fide* results in the way of actual cures were obtained in some of the early applications of electricity to the curing of disease appears to be beyond doubt, for the method of treatment in some cases remains practically the same to-day as it was at the time of the discovery of the Leyden jar. Then, again, in those days, as at present, the public's natural credulity led it to perhaps lay more stress on the few cases that were cured than on the more numerous cases that either failed to receive any benefit from the treatment, or were actually killed by it; or, putting the same thing in another way, the people who were cured gave glowing certificates of their cures, while the people who were killed gave none.

I have thought that it might interest you if I brought before you a few curiosities in the way of the astonishingly absurd statements that were put forth about the time of the discovery of the Leyden jar, as to the ability of the electric force to cure.

Unfortunately, I have been called upon to read this paper at an extremely short notice, and must, therefore, ask you to take, in many cases, my recollections of matters that I have read a number of years ago, in place of actual quotations from the original records.

Far be it from my purpose to throw any discredit on the medical fraternity as it existed in the latter part of the eighteenth and the beginning of the nineteenth century, or to throw any doubts on the value of electro-therapeutics as practised at the present day; for the great value to be derived from the intelligent application of electricity for curative purposes is no longer a matter of doubt.

In criticising some of the ideas presented in eletro-therapeutics, at the time of the discovery of the Leyden jar, it should be remembered that it is, of course, much

* Read before the Electrical Section of the Franklin Institute, September 27th, 1892.

easier to find fault with methods than to propose better methods; and when we remember the comparatively limited knowledge the world had acquired concerning the nature of the electric force at these early times, and the belief that was quite common in the scientific world concerning the presence of various effluvia, which were supposed to be capable of passing through the densest matter, we should criticise less harshly some of the beliefs put forward at these early times as to the proper method of applying electricity to the curing of disease. Indeed, an examination of the advertisements of some so-called medical electricians made even in these latter days, would unearth absurdities far more marked than those of the time we are discussing.

I once read in a circular letter issued, if my memory serves me correctly, some 15 years ago, by a certain so-called medical doctor, in which he claimed among other advantages for the peculiar kind of electricity which he claimed his apparatus was capable of producing, that it was electricity of the corkscrew or gimlet type, and that it, therefore, had but little difficulty in insinuating itself into all parts of the body, so searching out the disease. Or, taking a time not so modern, when a certain inventor, I think, by the name of Edward Craddock Monckton, an exceedingly ingenious man by the way, who has taken out scores of electrical patents, and among others a method of electrically joining articles of jewelry, gravely proposes in a British patent, to so connect the body of a healthy animal, like a cow, for example, with that of the patient to be treated, as to electrically convey the health and strength of the animal to the patient. To do this he places the body of the cow, or other animal upon an insulating stool, and connecting it to that of the patient to be treated by electric conductors, passes the current of a battery through the animal and subsequently through the body of the patient and thereby, as he claims, conveys to the patient the vitality of the animal.

Passing these aside, however, I would call your attention to a few curiosities in early electro-therapeutics.

It was believed by many of the early practitioners that the virtues of a drug could be readily caused to pass through glass vessels by means of electric discharges. This belief was probably founded on the rather prevalent belief at this time as to the existence of effluvia. The attraction of a magnetic needle by a magnet, notwithstanding the interposition of a plate of glass, was at one time explained on the supposition of effluvia passing out of the magnet and through the glass into the iron. It is not, therefore, surprising to find such statements as that of a Dr. Bruni writing to Dr. Watson of a remarkable case in which, as he claims, medicine shut up in a tightly sealed glass globe produced its peculiar effect on a person who was electrified by the use of said globe. I mention this as a particular case, although the early records of electricity are filled with similar cases. What Dr. Watson has to say about these experiments will, I think, interest you, and I will, therefore, give you the following quotation:

"Dr. Bruni gives me next in his information from Rome, which is, that a gentleman there covered the internal surface of a glass cylinder (which some use instead of a globe) with a purgative medicine; and that man, electrified therewith, found on the spot the same effect as if he had swallowed the medicine. He then recommended to us, in England, to try how far the electric power may be of service in distempers.

"These cases, and particularly the last, is it may to some appear extravagant and whimsical, I should have been cautious of bringing before the Royal Society, had you not judged it proper they should be added to those similar accounts from other places, which were read to us last meeting. I think neither myself nor Dr. Bruni answerable for the truth of these facts, as we relate no more than we have received. In truth, all the phenomena in electricity are so wonderful that it is scarcely prudent to deny the possibilities of any accounts concerning it till we have made experiments carefully ourselves. We are very sure it is possible to render a living body replete with electrical effluvia, or to transmit and send such effluvia through a living body, in a stream, as long as we think proper: we are not sure that it is impossible for these effluvia to convey with them into that living body the most subtle and active effluvia of other substances; and if they can do so, the effects suggested are not wholly improbable, for several experiments have proved that a very minute quantity of medicine, transfused directly into the blood and circulating fluids, will have the same effect as a large dose thereof taken into the stomach."

Somewhat similar to the effect just referred to was the belief that the odours of certain substances, placed in tightly-sealed glass globes, could be detected by sending electric discharges across them; or the similar belief that highly poisonous substances, placed in such glass globes, could produce deleterious effects on people when electric discharges were sent through the glass globes.

In the "Encyclopedia of the Arts and Sciences," published in 1798, the following account is given of the so-called medicated tubes:—

"It was asserted by Signor Pivati, at Venice, and after him by Verati, at Bologna, Mr. Blanchi, at Turin, and Mr. Winkler, at Leipsic, that if odoriferous substances were confined in glass vessels, and the vessels excited, the odours and other medicinal virtues would transpire through the glass, infect the atmosphere of the conductor, and communicate the virtue to all persons in contact with it; also, that those substances, held in the hands of persons electrified, would communicate their virtues to them; so that the medicine might be made to operate without being taken into the stomach. They even pretended to have wrought many cures by the help of electricity applied in this way. To see the wonderful effects of these medicated tubes, as they were called, Mr. Nollet travelled into Italy, where he visited all the gentlemen who had published any account of these experiments. But though he engaged them to repeat their experiments in his presence, and upon himself; and though he made it his business to get all the information he could concerning them, he returned fully convinced that in no instance had the odours been found to transpire through the pores of excited glass, and that no drugs had ever communicated their virtue to people who had only held them in their hands while they were electrified."

Franklin made a study of the effects of the so-called medicated tubes. In his "Experiments and Discoveries in Electricity," published in London in 1769, he says on p. 82:—

"Hence we see the impossibility of success in the experiments proposed, to draw out the effluvial virtues of a non-electric, as cinnamon, for instance, and mixing them with the electric fluid, to convey them with that into the body, by including it in the globe, and then applying friction, &c. For though the effluvia of cinnamon and the electric fluid should mix within the globe, they would never come out together through the pores of the glass, and so go to the prime conductor, for the electric fluid itself cannot come through; and the prime conductor is always supplied from the cushion, and that from the floor. And besides, when the globe is filled with cinnamon, or other non-electric, no electric fluid can be obtained from its outer surface, for the reason before mentioned."

In an article entitled "A New Discovery of the Usefulness of Electricity in Medicine," by John Henry Winkler, read before the Royal Society by Mr. Watson, March 31st, 1748, and published in abstract on page 399 of Vol. x. of the *Philosophical Transactions*, we find the following statement:—

"Electricity has a power of dividing subtilely. It carries off with it the parts of those bodies which it dissolves, and transfers them to those parts where the electrical sparks appear. If odorous substances are ever so closely confined in glass vessels, it so divides them that their exhalations penetrate the glass as easily as magnetical powers, and flow like a river through the atmosphere of cylinders and chains, to which the electricity is communicated. The electrical matter which comes out of the extremity of the cylinder gives an aromatic odour to the hand that touches it. But the odour communicated does not stop in that part of the body on which the electrical river has flowed, but with a continued aspiration pervades the whole human body. Not only the skin and garments are scented, but even the air breathed by the lungs, the spittle, and the sweat of the person affected smell of aromatics, which are agitated by electricity in the closed vessel."

So, also, the following account of a similar use on page 400 of the same *Transactions*:—

"About the beginning of the present year, 1748, I received a letter from Venice, which greatly confirms this conjecture. The author, Joannes Daniel Gaifel, related an affair which surprised all the learned of Venice, Bologna, and other cities of Italy. It was accompanied with a printed epistle in Italian, written by an eminent person at Venice, Sig. Jo. Franc. Pivati. In this epistle, the subject of which is medical electricity, he relates a story of wonderful effects to Sig. Fr. Maria Zanotti, Secretary of the Academy at Bologna; and the art by which these were performed was the invention of Pivati. A manifest example of the virtue of electricity was shown in the Balsam of Peru, which was so concealed in a glass cylinder, that before the application of electricity there could not be the least smell of it by any means discovered. A man, who having a pain in his side, has applied hyssop to it by the advice of a physician, approached to the cylinder. The man was electrified by it, went home, fell asleep, sweated, and dispersed the power of the balsam. His clothes, bed, chamber, all smelt of it. When he had refreshed himself by this sleep, he combed his head, and found the balsam to have penetrated his hair, so that the very comb was perfumed. The next day S. Pivati electrified a man in health after the same manner, who knew nothing of what had been done before. On his going into company about a quarter of an hour afterwards, he found a gradual warmth diffusing itself through his whole body. He grew lively and more cheerful than usual. His companions were surprised at an odour, and could not imagine whence it proceeded, but he himself perceived that the perfume arose from his own body, at which he was much surprised, not having the least suspicion that it was owing to the operation that had been performed upon him by S. Pivati."

Another equally curious early practice consisted in the use of what might be termed medicated Leyden jars, in which the inner coating of a Leyden jar, through which discharges were given, was formed of or contained liquids, consisting of aqueous solutions of various medical substances. On the discharges from such jars being passed through a patient's body, it was believed that the peculiar effects of the medicine dissolved in the liquid placed inside the jar could be experienced.

Of a similar nature is a rather extended belief which existed at one time as to the effects produced by sending electric discharges through solutions of medicine prior to their being taken into the system.

In a British patent, 991 for 1862, Frederick William Breary describes improvements in medicated cups, which consist practically in sending electric currents through the medicines contained in such cups prior to their being taken into the body. I will quote from the specification of this patent:—

"The third improvement of my said invention consists in the formation of similar cups or vessels in and by which the principle of galvanic action is obtained either in combination with the medicinal qualities above mentioned or otherwise. The drinking vessel formed upon this principle I denominate the improved medicated 'galvanic cup.'

"In applying the above-mentioned improvement to my said invention, I make a cup or other suitable vessel (for drinking or other purposes), also in two or more parts, and either form the same on either of the medicated principles above described, or otherwise, as may be required, and to fix or insert therein a voltaic or galvanic pile, and galvanise or medicate the water or other liquid placed therein by slightly acidulating the same. By preference, however, I form the foot, stem, and outer bowl of these cups or vessels of glass, china, or other non-conducting material, having three or more water-tight cells, or compartments therein, separated one from the other. I make the centre compartment occupy nearly the whole of the internal space, and make the two side compartments small, but sufficiently large to contain the galvanic media. The latter compartments are closed at the top by means of movable stoppers; the central compartment is made open for containing the medicated water or other liquid to be galvanised. The internal surfaces of the central compartment I line with metal or mineral on one part, and with wood or vegetable, as before described. Extending across this compartment, and forming a metallic connection between the two side cells, I fix a bar or perforated plate of metal. When using this galvanic cup, the water or other liquid is first placed in the centre compartment, where it is medicated; then, by filling the side compartments, one with granulated copper and fine sand, and the other with granulated zinc and fine sand, and adding to each a little acidulated liquid, the galvanic essence will pass or flow along, and over the metal bar or perforated conductor through the medicated water or liquid, and will impart its medicinal virtue to the same, and thus a combined medicated and galvanised action will be obtained."

IMPROVEMENTS IN ELECTRICAL DISTRIBUTION.

IT would be reiterating well-known facts to say that the distributing apparatus is the most important part of a system of electric lighting. There have been many attempts to reduce the enormous cost of mains, but hitherto there has been no system invented which can be considered cheap and good.

Messrs. J. E. H. Gordon & Co. have recently completed certain improvements in electrical distribution which have been patented by their chief engineer, Mr. T. Tomlinson, by whom they have been devised. These improvements are in two parts:—

The first refers to low tension mains, and is equally applicable to all kinds of distribution in which such mains are used.

The second refers to distribution of alternating currents on the three-wire system; that is to say, to the arrangement now so common, of causing the transformers at the substations to give 200 volts, and distributing the low tension current on the three-wire system.

With regard to the first improvement, low tension mains are at present laid either in the form of copper strips, which are placed in conduits and stretched, or in the form of insulated cables either laid in iron or earthenware pipes, or buried in the ground.

Great difficulties have been incurred by the copper strip system, as the entrance of any water into the trench destroys the insulation, and the giving way of any of the tightening appliances causes the strips to slacken and causes short circuits. They are further, when of a large size, not applicable to alternating current distribution.

The system adopted by Messrs. Gordon is illustrated in fig. 2, and in it the conductors consist of hollow copper tubes. These tubes are carried in porcelain insulators having the appearance of an ordinary nut or washer. They are simply slipped on to the tubes and laid in concrete trenches. The trench is then filled up solid with an asphalte of a special composition, which is extremely cheap, and can be poured in nearly cold. A piece of calico is then laid over the composition which prevents dirt and stones from falling into it. Then comes the final concrete which completes the trench up to the level of the paving stones (see fig. 5). The ends of the tubes open into the man-hole boxes, the cooling surface being considerable.

Alternating currents, which, it is well known, travel only in the outside portions of large conductors, can be passed with full effect through the largest size tubes used.

The stock sizes of tubes used by Messrs. Gordon vary from ¾ to 2¼ inches external diameter, the thickness from 9 to 19 guage, and are of a sectional area from ·1 to 1 inch.

Pilot wires, or telephone wires, if required after the mains are laid, can be drawn into the tubes; and in case the section of the conductor is at any future time not found sufficient, a bare copper strand can be drawn in to reinforce it.

The important feature of the system, however, is the self-healing properties of the insulating material. The first test of insulation resistance does not test quite so high as the highest class of cables, but it is practically impossible to injure it. In case of any fault occurring, a little heat is developed at the fault, which at once melts the asphalte in the neighbourhood, and it then flows in and repairs the fault.

In the course of the experimental test recently undertaken by Messrs. Gordon, a piece of wet clay fell upon the asphalte before it was set, and gradually sunk through it and formed

a connection across the two tubes. The insulation resistance at once fell very considerably, though not sufficient to stop the use of the mains. Bubbles appeared for about three-quarters of an hour over the point where the clay had sunk in, but at the end of that period the insulation resistance rose to its full amount, and the main appeared to be in perfect order. On removing the clay afterwards, it was found to be baked hard and dry.

It is intended to use this system, at present, solely for circuits not exceeding 200 volts, but Messrs. Gordon have an experimental length of it at Bray in practical work which has continuously 1,000 volts connected to it, and which remains in perfect order.

The second improvement, namely, the modification of the three-wire, is as follows :—

In the ordinary three-wire system a central wire has to be used throughout, which, in itself, is costly. A heavy royalty has to be paid to the owners of the patents, and in case of a considerable difference of load between the two circuits, either the voltages become different, or the loads have to be equalised by the use of a switching apparatus worked by hand.

In Messrs. Gordon's new system the current at 200 volts is conveyed from the sub-stations by two wires only to the various feeding points. At each feeding point is placed an equalising transformer, connected as shown in fig. 4. The two sides of this transformer are equal, or, in other words, its ratio or transformation is one to one.

When the loads on the two circuits are equal, the transformer does not act, and there is no loss by transformation ; but when the loads become different, current is at once automatically transformed from the circuit which is the least loaded, to the circuit which is the heaviest loaded, and the voltages of the two circuits are kept exactly equal.

Fig. 1 shows the general arrangement of town mains laid in this manner.

Fig. 3 shows an experimental test of the system.

A pair of circuits were connected, and one lamp was placed upon each. These lamps were placed on the two sides of a grease spot photometer, and adjusted for equality.

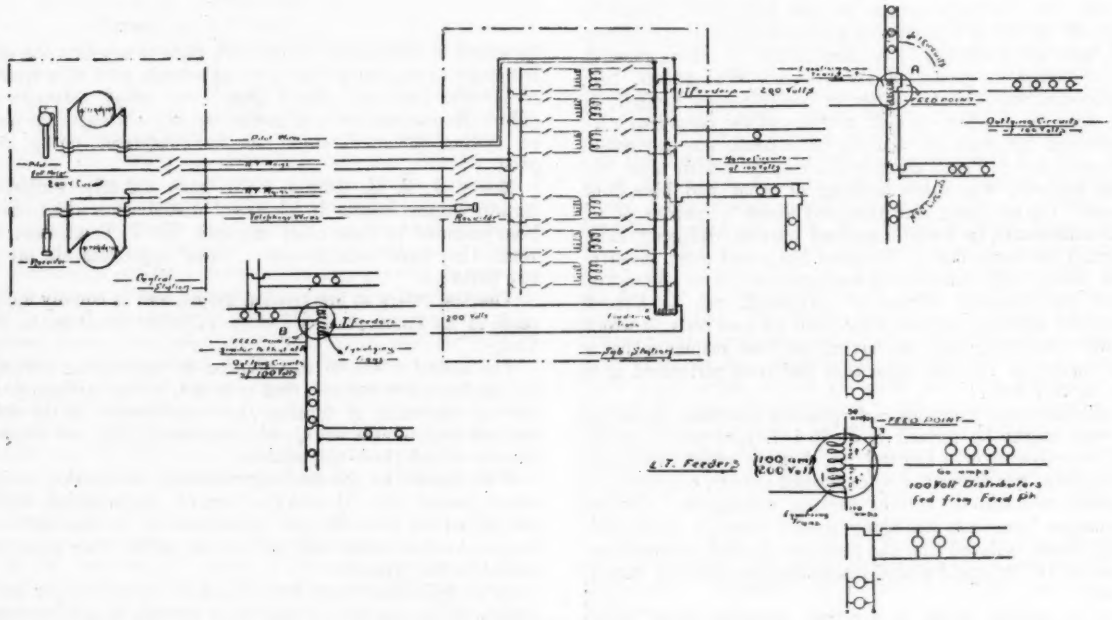


FIG. 1.

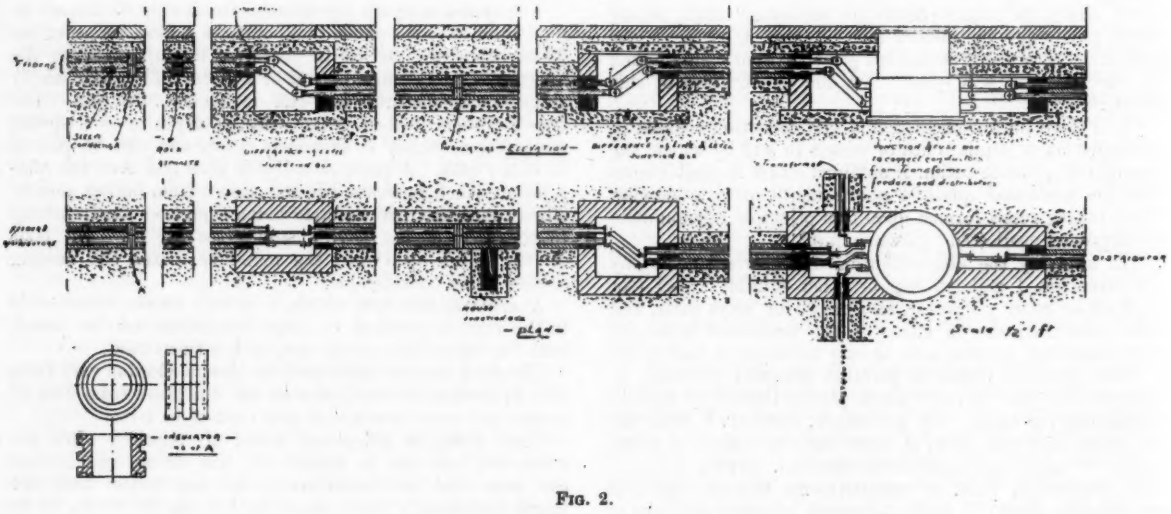


FIG. 2.

A liquid resistance, consisting of two metal plates in dilute acid, was then connected to one circuit in parallel with the lamp, and the plates were gradually approached until they were brought into contact and the fuses were melted. During the whole of this time the current on one circuit must have been at least a hundred times the current on the other, no difference whatever could be detected on the photometer in the brightness of the two lamps.

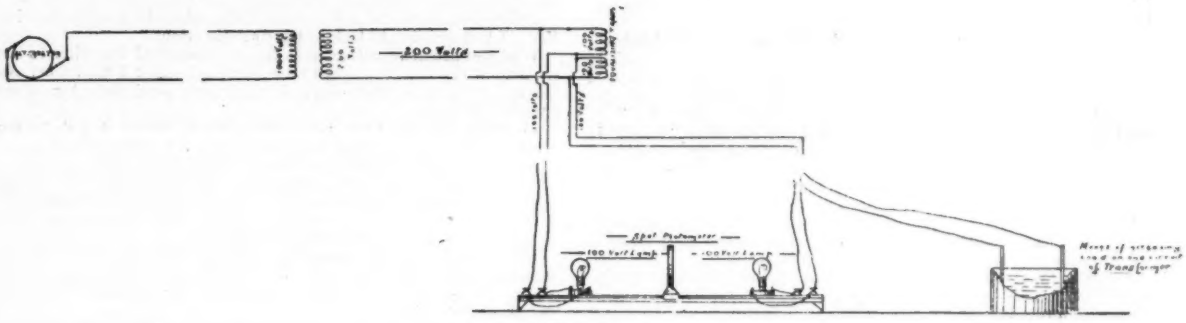


FIG. 3.

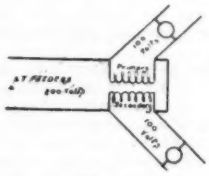


FIG. 4.

FIG. 5.

We cannot now publish figures showing the actual cost of Mr. Tomlinson's system, but we have been permitted to inspect comparative costs, and there seems every reason to expect considerable difference between this and other systems in the price per yard.

LEGAL.

THE THREE-WIRE SYSTEM.

DR. JOHN HOPKINSON *v.* THE ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

(*Continued from page* 640.)

The following evidence of Prof. S. P. Thompson was omitted from our last issue. It should be read before the evidence of Prof. Kennedy :—

SEVENTH DAY—NOVEMBER 23RD.

PROF. SILVANUS P. THOMPSON, further cross-examined by Sir RICHARD WEBSTER, said that if a man were going to establish the system he had drawn on the previous day, there would be no object in having a divided dynamo. With one dynamo the third wire would be useless. He had written many text-books on the subject of electric lighting, and had from time to time posted up the new editions with all the current knowledge. In 1882, in the course of four lectures delivered at the Crystal Palace, he endeavoured in brief to tell his hearers all he knew of the leading features of electric lighting. The diagram handed to him was the original paper from which his diagrams were made. As a matter of fact, he did not show in any of those systems a third wire taken back to a double dynamo. In any one of those systems a single dynamo would work perfectly well.

Can you point to any enunciation of the value of the three-wire system in general, prior to Dr. Hopkinson's specification?—The nearest thing I think I can refer you to is a description of the dynamo with three terminals.

Where is that to be found?—Page 290 of Volume I. of "Electric Illumination."

When was that published?—August, 1882.

That is after Dr. Hopkinson's patent?—Yes.

Have you ever tried Inchicore with two bridges on one side and three upon the other?—No.

Is it not the fact that if you try Inchicore in that way, the lamps will not burn equally?—I do not know it.

Will you tell me, in 1882, of any direction in any text-book or elementary work which would lead people to couple alternating dynamos other than rigidly?—I do not know that I ever saw any directions to couple them rigidly until 1884.

Do you suggest that the practice was not to couple alternating dynamos rigidly in 1882?—I do not think it was.

Do you know of anybody who has made a machine exactly according to the patent, and has found it would not work?—No.

You saw the one working here, and working well?—Yes, but that was on a constant current.

Is this model made according to the specification?—Essentially.

Will you undertake to say that, put on to an alternating current machine, won't work perfectly?—I think it will not in all cases.

Cross-examination continued: In the system shown (fig. 1), there were a number of bridges, and, in that sense, it was a multiple system. In fig. 5 there were a number of bridges put across; and that, too, was an instance of parallel distribution.

Re-examined by Mr. FINLAY, Q.C.: Is the use of the third wire advantageously applied to systems other than those of parallel distribution?—Yes, in all cases of distribution save one. The case where it has no advantage is where the dynamos that are used two together are of a kind called constant current dynamos which supply an invariable current; for in that case, if the dynamos provide an invariable current, the middle wire can never have anything to do.

Mr. JAMES SWINBURNE, examined by Mr. FINLAY, said he had been the manager in different factories, and was the senior partner in the firm of Swinburne & Co. Every arc lamp that he knew of in 1882 would work in parallel—most of them in series also. In the specification he found nothing confining the patent to a system of parallel distribution, only to a system of constant potential. He thought that a system of constant potential was what Dr. Hopkinson had in his mind.

Mr. JUSTICE ROMER: Suppose it was confined to a system of conductors for a supply at a fixed potential, what would it exclude?—Series arc lighting with an intermediate return in the middle.

Examination continued: Distribution in 1882 referred to distribution in series as well as in parallel. What he meant was, that a system of constant potential was what Dr. Hopkinson was aiming at; he did not say that an electrician would have thought the specification was confined to that. In comparison with the parallel arrangement, the Alexandra Palace and Inchicore installations saved copper and energy. He disagreed with the evidence of Mr. Andrews to the effect that if a workman at Inchicore put a bradawl across the instrument and short circuited it with the result that the lamps went up in brilliancy, that showed that the system was not the three-wire system. He thought it was quite possible that with an old machine of the type used then, short circuiting one side might increase the electromotive force on the other. Shortly, assuming that experiment to be established, it proved nothing either way. In 1882 a clever fellow might have thought it necessary, in using alternating current dynamos, that they should be rigidly coupled up, but certainly most people would not. He, himself, would not have thought of it. He had considered the possibility of making a regulator such as was described in the plaintiff's specification which would work with alternating currents. There were many ways of making such regulators; some would work and some would not. He had had one made (as he thought) in accordance with the specification, and found that it could not be made to work.

Cross-examined by Mr. MOULTON, Q.C.: Any electrician who knew that with alternating currents the dynamos must keep in step, would have knowledge enough to know that they must be rigidly coupled. He was not prepared to say that the model of the plaintiff's indicator

put to Lord Kelvin, and admitted by that gentleman to be fair, would not work when applied to an alternating current; but if anyone tried it in 1882, and allowed for a part of the current only going through, it would not work. The arrangement of the coils in witness's model slightly aggravated the mischief from the mutually-induced currents. In order that the consumer might take his electricity at a fixed potential, it was necessary that the currents coming out of the stations should vary.

Is it possible to have a system in which the mains are at constant potential wherever tapped by the customer, without that being a parallel system?—It is possible in the case of its only being tapped once.

You do not think that Dr. Hopkinson was thinking of the case of tapping the main once?—No; but any man coming shortly after this and putting down an installation with two motors each tapping it once, would consider that he was infringing Dr. Hopkinson's patent.

Where the patentee talks of "feeding conductors," does not that essentially point to a parallel system?—He was certainly talking of parallel there.

With the exception of the Gülcher lamp, can you tell me any kind of arc lamp known to be capable of being worked in parallel?—I don't know of any that were, except the Gülcher.

WITNESS then said that Siemens lamps of the 1882 type would stand being short-circuited. He did not know whether, unless the engine ran away, the other lamps would get brighter in the event of short-circuiting.

Re-examined by Mr. FINLAY, WITNESS said the ordinary intelligent workman in 1882 would not have known that in the case of alternating currents the dynamos would have to keep step. The loss occasioned by the arrangement of the coils in his model regulator was not substantial enough to require to be taken into account, practically.

Mr. HUGH ERAT HARRISON, a Bachelor of Science, and Principal of the Electrical Standardising, Testing, and Training Institution, London, said he tested a regulator put into his hands by Mr. Swinburne, with fixed currents, and it acted, but not well. A like test with alternating currents had no results. The test was carried out in accordance with the directions in the specification as to connection, &c. He found nothing in the specification which would show how the regulator could be made to work with alternating currents. He was willing to experiment with the model of the regulator which was put to Lord Kelvin.

Sir RICHARD WEBSTER had no objection to the witness experimenting with the model referred to.

Examination continued: He disagreed with the evidence of Lord Kelvin, Dr. Hopkinson, and Sir Frederick Bramwell to the effect that the plaintiff's regulator could be used with alternating currents, except in the case of the whole of the current passing through the thick wire coil.

Cross-examined by Sir RICHARD WEBSTER: He was first seen in connection with this case the day before yesterday. On that night he first gave consideration to the evidence respecting the plaintiff's regulator. There were, he knew, many competent electricians who thought that mutual induction was more important than self-induction, but he could not separate the two. Mr. Swinburne's arrangement of the coils would increase the mutual induction, but only slightly. He thought that if only a proportional part of the current were sent through the model of the regulator exhibited for the plaintiff, the model would not work; if the whole current were sent through, he thought it would. If a competent witness said that he had seen the model so worked, he should be bound to admit that it had. He could not say whether alternating machines were the oldest, but they had been used for a number of purposes prior to 1882. Supposing the alternating machines did not work together, the push of the one would neutralise the pull of the other, more or less. He knew of no direction in any book which would lead a gentleman minded to use two alternating machines to couple them otherwise than rigidly.

Re-examined by Mr. FINLAY: The thick wire on the model of the regulator made by Mr. Swinburne was put on at Faraday House at the request of Mr. Swinburne.

In answer to Sir RICHARD WEBSTER, WITNESS said that when his experiments with the regulator were made, nobody was present on behalf of the plaintiff.

Sir RICHARD WEBSTER said he hoped his Lordship would allow the plaintiff's model to be tested in the presence of representatives of both parties.

Mr. JUSTICE ROMER: Certainly.

Adjourned for lunch.

EIGHTH DAY.—NOVEMBER 24TH.

Mr. RANKIN KENNEDY was further cross-examined by Sir HORACE DAVEY, Q.C.

Is it not the fact that before you went to the Crystal Palace you did not go regularly to the workshop?—Yes; I went regularly.

The electrical experiments with reference to your lamp were not conducted at the workshop, were they?—The testing was not conducted at Sauchiehall Lane, but all the electrical work was done there.

The testing was not done at the workshop—where was that done?—At Polmadie.

Is it not the fact that you did not go to the workshop in Polmadie before you went to the Crystal Palace, but you used to conduct your business at Mr. Muir's office?—Mr. Muir had no office to my knowledge at all.

Do you say that there was no incandescent electric lighting that you saw at the Sauchiehall workshop before you went to the Crystal Palace?—No; there was no regular lighting. I have seen one or two lamps there lighted occasionally—not more.

The lamps that you say were Maxim lamps?—They were.

Those lamps were placed in the circuits of the wires connected with the Siemens dynamo?—They were.

Did you examine the way in which those lamps were attached to the wires?—No; I did not.

Then you cannot tell me whether some of those lamps were attached to what I call the first and second wire, and some to the second and third—that is, to the outside and inside wires?—No.

Did you examine the connection of the wires to the dynamo?—Yes. I had occasion to look to the dynamo often.

Was your attention attracted to the attachment of the wires to the dynamo at the time the lamps were burning?—No; I do not believe I examined them at that time. I never saw more than two come from the dynamo.

It would require very close examination, would it not, to see whether two or three wires were attached to the dynamo?—No.

Do you mean that a casual passer by would see?—Yes.

I understand from your examination yesterday that you agreed with my witnesses that there were three wires, but you disagree with them as to the third wire being connected with the dynamo. That is the point of difference between you?—Yes.

Mr. Andrews says he personally connected that third wire with the dynamo, and he was responsible for the running of the lamps in that state. Do you feel sufficiently positive on the point to contradict Mr. Andrews?—I do.

You said yesterday that if a third wire went back to the dynamo, you would not necessarily have seen it?—Only two wires were visible. They came down straight from the roof.

Mr. JUSTICE ROMER: If a third wire had been hanging from the roof, would you have seen it?—Certainly.

The third wire was disconnected?—Merely disconnected.

A workman would connect the wire in a few seconds?—In half an hour.

When you came back from the Crystal Palace, you altered that Siemens dynamo?—Yes.

But the dynamo was not yours?—Mr. Graham, the managing director of the company, gave me permission to use the dynamo as I liked.

Re-examined by Mr. ASTON: Your lamp, if successful, was to be placed at the disposal of Mr. Graham?—Entirely.

With what object did you examine the dynamo?—I wanted to understand its construction. Dynamo-making was my particular study at that time, and this was the first Siemens alternating machine I had an opportunity of actually having in hand.

Mr. DAVID GRAHAM, examined by MR. HOPKINSON, Q.C., corroborated Mr. Rankin Kennedy's account of his connection with the Electrical Company and Mr. Kennedy. He said, further, that for the purposes of his company he ordered a 2 H.P. Otto engine. The premises at Sauchiehall Lane were taken on a weekly tenancy. He was considerably the largest shareholder in the company. Mr. Kennedy was regularly working for the company, and had witness's permission to carry on any experiments he chose.

You know what the three-wire system is?—Yes, now—not then.

Did you see anything of that sort at Sauchiehall Lane?—Nothing whatever.

Did Andrews tell you anything of that kind?—Never spoke of it. He was working under me.

WITNESS went on to say that they never sold an incandescent lamp manufactured at Sauchiehall Lane, none being produced fit for sale.

Was this, in your view, a public or a private workshop?—Perfectly private. It was up two floors; it was on the second floor, and entered from a back lane, and up a back stair.

Was it a place where you expected people to come in without your permission?—Certainly not; even Dr. Bottomley always came to me before going up.

Cross-examined, WITNESS said that he was the first person who introduced the incandescent system into Scotland, and he had done many jobs since. He had had no technical education in electricity, but would leave others to judge whether he was an electrical engineer. He only saw two main wires from the dynamo, but he did not examine it particularly.

Re-examined: He had never heard of the use of the three-wire system at Sauchiehall by Andrews or anybody else until this case was brought up. Andrews's discoveries were to be at the disposal of the company; he was engaged on these terms.

Mr. DAVID JOHNSTON SMITH, the Secretary of the National Electric Company in 1882, said nothing was successfully manufactured at the Sauchiehall workshop, or sold. The workshop was private.

Cross-examined: If anybody had requested to be allowed to see what was going on, whether they were refused, would depend on who they were; he never had occasion to refuse anybody, and never heard of anybody being refused. It was not within his knowledge that many people had been shown over the place; he had heard of some. So far as he knew, the workmen were not put on any terms of secrecy.

Mr. WM. MACFARLANE, who was engaged in instrument making at Sauchiehall Lane from March until July, 1882, said that during that period the workshop was not lighted by incandescent lamps, but by gas. Two wires from the ceiling were connected with the dynamo. When the workmen connected the wires with a metal tool, one lamp went out, whilst the other blazed up and made a hissing sound. When anyone visited the shop they were always under the conduct of somebody connected with the company.

Cross-examined: He saw incandescent lamps placed upon the wires in the workshop. They burned, but were not used for lighting the shop. There were only two main leads running round the room.

Mr. JAMES CURRIE, who about March, 1882, went to Sauchiehall workshop as a glass-blower, said the place was lighted with gas. He saw one Maxim lamp there.

Mr. HENRY ELGIN, a clerk in the employ of Messrs. Crossley Bros.,

of Openshaw, near Manchester, produced an order from Mr. Graham for a two horse-power engine.

Cross-examined: He believed that would work up to 3 decimal something.

Mr. ROBERT WILSON, Messrs. Crossley's manager, said that engine would drive from 24 to 28 lamps of 16 candle-power.

Cross-examined: He would not go into the question of voltage.

Dr. JAMES THOMPSON BOTTOMLEY, examined by Mr. MOULTON, Q.C., said that he had for many years worked with Lord Kelvin at his electrical experiments, and had had a great deal of experience in electric lighting. At Mr. Graham's request, at the end of 1881, he did all that lay in his power to make the installation at the Fine Art Gallery a success. From November 14th, 1881, he was frequently at the Sauchiehall workshop. As far as he knew, everything there was shown to him.

Either at the Fine Art Gallery or at Sauchiehall Lane, did you ever see any arrangement wherein a third wire was taken back to the middle point between the dynamos or coils in series?—No.

And was the three-wire system a novelty to you when you heard of Dr. Hopkinson's discovery?—Yes, it was.

WITNESS was then handed the models of Dr. Hopkinson's regulator put in by the plaintiff and the defendants respectively. He said that the former was manufactured in accordance with the specification, and he had seen it successfully work. In the latter, the thick coil was put round the thin coil, while in the former the coils were end to end. The effect of that arrangement, when put on the alternating system, was to enlarge the mutual induction, which was the chief disturbing element.

In cross-examination, WITNESS adhered to his statement respecting the regulators. He said, further, that his attention was not specially called to the dynamo or the number of wires connected with it on the occasion of his visits to Sauchiehall Lane.

Dr. HOPKINSON, re-called, spoke to the experiments with his regulator on the previous evening. He said that if it had been on an actual installation it would have indicated the pressure at the end of the feeder where there was one-eighth of a volt difference between the two connections. That was a practicable difference to obtain in a real working installation. With regard to the experiment of shot circuiting the thick coil, he agreed with Dr. Bottomley that that exaggerated the mutual induction.

Cross-examined: In order to translate that experiment into practice, preserving all the conditions of it, preserving relatively the high resistance which was shown in that experiment in practice, you would make the connection at such a distance from the station as would be practically useless?

WITNESS: No, you would not. The resistance has nothing to do with it. If you are working with 1,000 ampères instead of 25, you would work with very much smaller resistance in your main leads. This experiment satisfied me beyond the slightest shadow of doubt, that with this identical instrument I could at once put it upon working circuits with 1,000 ampères, and I should know what to do.

COUNSEL repeated his question.

WITNESS said that if what was proposed were done, the instrument would be put into a condition in which it would be absolutely absurd, and which no sensible man would dream of.

Re-examined: If the proper amount of potential between the two ends were kept, the regulator would work on a large installation. Sir Horace Davey had got into confusion between the necessity of keeping a proper degree of difference of potential between these two ends and the resistance between the two points.

Lord KELVIN, recalled and further examined by Mr. ASTON, said that in March and May, 1882, he went to the Sauchiehall workshop at the instance of Mr. Graham, who was desirous of obtaining his assistance in his electrical enterprises. He believed that everything interesting and novel that could be shown in that workshop was shown to him. He could not recollect exactly when he first learnt the three-wire system. To the best of his recollection, it must have been more than a year after that time, and then the two names of Edison and Hopkinson were mentioned to him as names of joint or independent inventors of that method. He had no recollection of being shown anything, or seeing anything, during any one of his visits to Sauchiehall Lane like the three-wire system of Dr. Hopkinson. He saw nothing which could suggest that system to him for public lighting. The plaintiff's model of the patentee's regulators corresponded absolutely with the specification. The defendants differed from the drawing in having a thick coil outside the thin coil. That was a material difference, as it would largely increase the mutual induction between the two coils. That morning he had tried the plaintiff's model to ascertain whether it would work in the manner proposed in the specification, and he could now undertake himself to place it on any installation for public lighting, however large, and make it work within a close percentage. To do that he should not have to depart from the specification of Dr. Hopkinson at all. There could not be the slightest doubt about it being a useful invention, or that it was sufficiently described in the specification. It could be applied to alternating or continuous currents.

Cross-examined: Have you any suggestion to account for this valuable invention never having been practically put into operation?

WITNESS: I am scarcely called upon to account for that; but I am not surprised that it is so from much knowledge that I have as to useful inventions which people have refused to use for 10 or 15 years, and which ultimately they are beginning slowly to use.

WITNESS having stated that in the experiments made by himself and Mr. Bottomley for testing the efficacy of the instrument, they did not use a short circuit to the coil, but used a coil as represented in the specification, gave elaborate figures, from which it appeared that the relative resistance of the portion of the main which was tapped by the regulator, and the wire which went round the coil, was about eight and a half times as much as that of the thick coil. An actual installation on that scale, with those relative dimensions, would not be practicable; but he should never dream of using such a proportion. His recollection did not go to seeing lamps lighting workshops; but electricity was being consumed in "flashing" and "running on the pumps." His attention was not particularly called to wires, by means of which the current was conveyed for the purpose of these processes, and he could not undertake to say whether there were two or three.

Mr. GEO. BICKHAM DUNN said he had charge of the generating station at Sardinia Street, belonging to the Metropolitan Electric Supply Company. He remembered some compensators being ordered from the Westinghouse Company when that installation was put up, but they were not used, because that company required neither them nor pilot wires, in consequence of having large leads and short mains.

Cross-examined, WITNESS said they had used neither the compensators nor anything equivalent.

Mr. JAMES SWINBURNE, recalled, said, in answer to Sir HORACE DAVEY, he was present at the Westinghouse office on the previous evening, with others, when the regulator was tested. The effect of increasing the resistance of the main was to overcome the error due to the self-induction of the circuit. That was the important objection to the whole thing. Supposing that installation had been converted into actual practice, preserving the same relative scale in every respect, the regulator would not be a practical thing. The conditions of the experiments were arranged by the plaintiff; he was only an onlooker.

Cross-examined: You have heard Dr. Hopkinson and Lord Kelvin both say that it enabled them to say how the instrument behaved?

WITNESS: Yes.

Do you contradict that?—Yes.

I am satisfied if you contradict it. We shall be able to judge. You say that that did not enable you to tell?—No.

This concluded the evidence.

Sir HORACE DAVEY, Q.C., at once proceeded to sum up the case for the defendants. He said he was bound to say that to his mind the case appeared to him to be one of an extremely simple character, depending on the construction of a document which was not difficult to construe, and which contained, comparatively speaking, few technical expressions. The question was really this: If the specification of Dr. Hopkinson, according to its true construction, was so framed as to describe, or comprise, the use of a third wire in connection with incandescent lamps and with lamps arranged in series as well as in parallel, then that they had Dr. Hopkinson's admission that it was anticipated by the Inchicore experiments, and he (Sir Horace) said by the installation at the Alexandra Palace. Not only had they the admission of Dr. Hopkinson to that effect, but he inferred from the cross-examination that his learned friends would not contest, if he were right in what he was submitting was the construction of the specification, that putting it either way—leaving out the contested Andrews case, with regard to which he conceded the evidence was not altogether satisfactory—the patent was anticipated. Or it might be put in another way, as Prof. Kennedy put it—that there was no invention in using an incandescent lamp instead of an arc lamp, or, if you had an arrangement of two or more lamps in series with a third wire, in adding another bridge of lamps or increasing the number of bridges carrying lamps. Of course the two propositions were different. The one proposition was that according to the true construction of the specification the specification did comprise the two arrangements he had alluded to; the other was, assuming that for some reason the Court should be induced by his learned friends to hold that the specification in its description and claim was confined to incandescent lighting in parallel arrangement, the question would arise—upon which he was rather surprised no cross-examination was directed—could a patent be had for substituting one sort of lamp for another, or adding one or more bridges in parallel to an already existing series of lamps? If, on the other hand, his Lordship should think that the specification according to its true construction excluded anything but lamps and electricity consuming appliances arranged in parallel, and that there was sufficient subject matter to extend the use of the third wire from arc lights used in series to incandescent lamps used in parallel, then he did not contest on this branch of the case that the patent was valid. Therefore, it appeared to him, without prejudice to the other points raised in argument at the bar, and by his expert witnesses in evidence, that the main question was one of construction. Sir Richard Webster, in his cross-examination put to Prof. Thompson, the question, "Is there anything in the specification which would lead a workman to use the three-wire system in connection with a system of arc lighting not in parallel?" That was an extremely adroit and ingenious question; but he ventured to think it would not withdraw his Lordship's mind from that which was the real question. The real question was not whether there was anything in the specification which pointed directly and in express language to the use of lights in series, or of arc lights as distinct from motors or transformers, but whether the description properly construed by the Court did or did not include those things. Let it be admitted that what the patentee had primarily in his mind was electric lighting by incandescent lamps arranged in parallel. That did not answer the question. The question was whether he had not drawn his description in such wide terms as to cover other uses besides that which was primarily in his mind; so that for example, such installations as those at the Alexandra Palace and Inchicore would be infringements if they had taken place after the date of the patent. No doubt the explanation of words of art, or words used in a particular trade or business or science, was a question upon which the Court could legitimately hear evidence; and if there were any technical words in this specification—of which he was not aware, it being one of which "he who ran might read"—by all means let them be explained by the evidence scientific gentlemen had given. But he protested that the meaning of the specification must be decided on the ordinary principles on which

documents were construed in that court, and not by the views or opinions of gentlemen, however highly placed and eminent they might be in their profession or particular line of life. He was not going to trouble his Lordship with the mysteries of simple multiple arc, or compound multiple arc, because it did not appear to him that the patentee had used the expressions in a single place, and because they were wholly irrelevant, and only calculated to throw dust in their eyes and obscure that which was sufficiently clear. Further, he protested against the doctrine which had been assumed by his learned friends, that if it could be shown that the patent as described was not useful for a particular arrangement or a particular installation, therefore, that arrangement or installation or use of the process was not within the patent. Upon that fallacious argument his learned friends had expended much of their time. It had been said, and unsuccessful endeavours had been made over and over again to prove that Dr. Hopkinson's three-wire system was no use in arc lighting, or in an arrangement other than parallel. In other words, his submission was that the Court could not hear evidence as to whether a particular application of a described process was useful or not, and, if it came to the conclusion it was not useful, construe the patent with reference to that evidence. His Lordship was told by Sir Richard Webster (no doubt upon instructions) that this specification was confined to incandescent lighting. He did not think anything more would be heard from his learned friends' side of the bar. First, because their own witnesses would not support it, because Dr. Hopkinson said the word "house" might be substituted for an "electricity consuming appliance," and that his patent was to be applied to all kinds of electricity appliances; and, next, because there was not one word which would lead to that conclusion in the specification. He would be surprised to hear his learned friends say the patent was confined to lamps at all, still more, that it was confined to incandescent lamps. The argument on the other side was this—that the first invention described, and for which a monopoly was claimed, was a regulator, for the purpose of working installations with a fixed potential. And, said his learned friends, you only require a fixed potential where you have incandescent lighting in parallel lamps. His (Sir Horace's) witnesses did not approve of that. But he might admit it, and he cheerfully gave them the benefit of the admission that the regulator was only useful where a fixed potential was required—that an instrument to secure fixed potential was only useful where a fixed potential was wanted. But what did his learned friends say? Because his first invention was only applicable where a fixed potential was wanted, and you only wanted a fixed potential in incandescent lighting in parallel arrangement, *e.g.*, in his second invention you are to infer (in defiance of his language) that he means to confine it to arrangements in which you have a fixed potential also, although when you come to look at the language a fixed potential has nothing in the world to do with the third wire arrangement.

Mr. JUSTICE ROMER: Look at page 3, line 7: "My improvements principally relate to maintaining the electromotive force in a system of conductors for an electric supply at a fixed potential, but they also relate to the cost of *such conductors* consistently with efficiency and safety." The argument against you is that the fixed potential is useful for both.

Sir HORACE DAVEY contended that the fixed potential referred to the maintaining and not to the description of conductors. The object of the third wire, he said, was to enable two or more lamps to be used in series in such a manner that the number of those on one side could be reduced without affecting those on the other. If, in the case of arc lamps there were four on one side and five on the other, the excess of current instead of passing to the other side and destroying the lamps would go down the third wire and be carried off.

Mr. JUSTICE ROMER understood that in that case nothing would go down the central wire—that if one were turned off the whole current would go round the circuit if the lamps were in series.

Sir HORACE DAVEY said that according to the evidence of Profs. Swinburne, Thompson and Kennedy that was not so. According to the evidence with the lamps which Crompton used at the Alexandra Palace the third wire enabled him to turn out one lamp and then the whole current, instead of passing on to the other lamps, returned down the third wire and enabled two arc lamps to be used in series. The learned counsel gave his lordship reference to the evidence. It was quite possible, he said, that the patentee contemplated several parallel bridges. But was that a *sine qua non* of his description? Had he not advisedly confined his description to the essential elements in it, namely, the two systems of lamps arranged in series divided by a third wire running back to the dynamo. If the patentee intended to confine that to several series placed in parallel, why on earth didn't he say so? What was all this fine-drawn subtility about? The English language was perfectly plain. He (Sir Horace) therefore said that in this general description of the third wire system there was not one word which necessarily implied or led the mind to assume or believe that it was an essential element of the system that there should be more than one series, because all the patentee spoke of was systems of lamps are appliances placed in series with a wire from a point between them running back to the dynamo. If it were incumbent upon him (Sir Horace) to prove that system would admit of such arrangements as they had at the Alexandra Palace, the testimony of the witness was quite sufficient. The system might be the more useful the more bridges you put on, but he could not see that more bridges than one entered into this description, or that that was any reason for confining the description or introducing phrases where the patentee had not confined it. But he entirely denied that in the case of motors or heaters it was any the less useful because there was only one series. It was of extreme use in the case of motors in the saving of copper, and enabled motors to be used in series when otherwise they could not. The varying load in a motor took up a varying amount of current, and the excess of the current taken up passed down the third wire instead of passing down its neighbour on the opposite side and choking it.

Mr. JUSTICE ROMER called attention to the words, "For the purpose of economising the cost of main conductors, I place two dynamo machines in series, and I place two systems of lamps or other appliances consuming electricity of approximately equal capacity also in series," &c. He said it occurred to him that the other side might say that this kind of patent chiefly concerned a *system* of lighting, and that its advantages were only obtained when you had practically more than one lamp, and that, therefore, in a simple case of two lights or two series in parallel you did not get the advantages of the patent—that it did not come within the patent, though not expressly disclaimed.

Sir HORACE DAVEY said his answer to that, in the first place, was that if the Alexandra or the Inchicore installation had been subsequent to the patent, could it have been plausibly argued they would not have been infringements? His second answer was if the system was good on a small scale could anybody else have a patent for identically the same system in principle applied to lighting a town, in which case the advantages would only be more widely and largely experienced? Of course not. It was the same thing in principle whether you had one series or a hundred. Where could the line be drawn? The real answer was that the patentee had never said that such a simple case was not within the patent. His learned friends suggested that he had in using the word "distribution"; but Prof. Thompson said that word did not so limit the plaintiff's claim, and no cross-examination was addressed to him on that point.

The learned counsel had not concluded his address when the Court rose for the day.

(To be continued.)

BRIGHTON ELECTRIC LIGHTING.

AT a meeting of the Brighton Town Council held yesterday, a report was to be presented by Mr. A. Wright, the manager of the Corporation Electric Light Works, conceding the lighting by electricity of the whole of the front from the western boundary of the municipal borough to the Aquarium. The lighting will be effected by 40 arc lamps, 20 on each side of the sea promenade, from dusk till 11 p.m., and thereafter until dawn by 16-candle-power incandescent lamps placed under an enamelled reflector on each of the 95 existing lamp standards, or on as many as are absolutely necessary. The report says:—

"The above-mentioned 40 arc lamps will consume nearly 30,000 units per annum, amounting, at 7d. per unit, to £875, and the cost of the incandescent lamps, from 11 p.m. to dawn, will be £337, making the total cost of lighting the part of the sea front described, about £1,212 per annum, that is to say, £290 per annum in excess of the present cost of gas, while the amount of light between dusk and 11 p.m. will be nearly five times as great, and after eleven will exceed that at present derived from gas. For the purposes of this supply, additional plant will have to be laid down, and from present indications the best form this latter could take would be two sets of very high discharge storage batteries, to cope with our numerous early customers or such irregular ones as the Pavilion, and a 30-H.P. steam dynamo for the general increase of the demand. The approximate capital outlay, chargeable to the electricity works, required for the above will be as follows:—For increasing the capacity of the mains, £5,985; for one 300-H.P. steam dynamo, £2,020; for one new boiler, £680; for two sets of storage batteries, £2,600. There will also be required 40 arc lamps on special lamp posts and 95 incandescent lamps, which, with the material and labour of erecting, will cost about £2,700, but this latter sum should be charged to the General District Fund Account."

The total cost of the King's Road scheme will thus be £11,985. The report is dated July 8th, 1892, nearly five months ago. In their comments on the report, the Lighting Committee point out that, apart from the capital outlay, the charge upon the district fund will be only £1,212 per annum, and they recommend "that the suggested alteration be carried into effect; that notice be given to the Brighton and Hove General Gas Company to terminate, on June 24th next, so far as relates to the King's Road, the contract with the company dated October 31st, 1890, for the supply of gas to the street lamps on the King's Road and Marine Parade; and that application be made to the Local Government Board for sanction to borrow £2,700, for a period of 30 years, to defray the cost of the new lamp columns, lamps, and appliances."

For the extension of private lighting, Mr. Wright recommends the following expenditure:—

	£	£
King's Road lighting and increasing capacity of mains (as stated in report, July 8th, 1892)		3,985
Additional mains in present area of supply		1,507
Mains in extended area of supply		12,330
New house services		2,800
Additional plant, specified in report of July 8th last	£5,300	
Ditto, in this report	5,730	
		11,030
Extension of buildings		1,500
Coal shed and store		180
		33,332
Contingencies		1,668
		£35,000

The above, it should be noted, does not include £2,700 debited to the District Fund Account in respect of King's Road.

The approximate financial statement of the revenue for the year 1892, presented by the committee, is as follows:—

REVENUE ACCOUNT.

	£	s.	d.
To Generation of Electricity—Coals, £820; oil, waste, water, and engine-room stores, £150; wages at works, £725; repairs and maintenance (buildings and machinery), £50 ...	1,745	0	0
„ Distribution of electricity—Repairs, maintenance, and renewal of meters, &c. ...	10	0	0
„ Rates and taxes	50	0	0
„ Management expenses—Salaries of permanent staff, £550; printing and stationery, £55; general establishment charges, £90	695	0	0
„ Special charges—Insurances, £13; commissions on installations, £75	88	0	0
„ Balance—Carried to net revenue account	2,329	16	9
	£4,917	16	9
By Balance brought from last account	4	2	5
By Revenue—Electricity sales and meter rents	4,913	14	4
	£4,917	16	9

NET REVENUE ACCOUNT.

	£	s.	d.
To Interest	1,238	4	4
„ Sinking fund	983	1	9
	2,221	6	1
To Balance (net profit) carried down	108	10	8
	2,329	16	9
By Balance from revenue account	2,329	16	9
	£2,329	16	9
By Balance (net profit) brought down	108	10	8

In conclusion, the committee further recommend as follows:—

1. That application be made to the Local Government Board for sanction to borrow a further sum of £35,000 for a period of 30 years for the purposes of the Brighton Corporation electricity works.

2. That the portion of the premises belonging to the corporation and adjoining the electricity generating station on the south, shown on the plan submitted herewith, be appropriated for the purposes of the undertaking, and that a proportionate part of the debt, created for the purchase of such land, be transferred to and charged upon the undertaking.

3. That the committee be authorised to carry out the works described in this report, and to obtain such contracts as may be necessary for the purpose.

The report further recommends that: "The electric lighting at the Royal Pavilion being now provided for from the North End Station, the plant at the electric light station in Church Street is for disposal. Concerning this, the Works Committee submit another special report. The original cost of the plant was £2,280 13s. 11d. The borough engineer and surveyor estimates its fair valuation at the present time, if it can be utilised, at £721 1s. 10d. engines, &c., £729 7s. 9d. dynamos, total £1,450 9s. 7d. It must not, however, be assumed that anything like that sum would be realised if the machinery had to be disposed of by auction or any forced sale."

CHICAGO EXHIBITION.

THE effect of the presidential election on the electrical industries of the United States is the subject of a leading article in the New York *Electrical World*, of November 19th. Our contemporary assumes that the present tariff will be reduced, and arrives at the conclusion that it will affect the buyer favourably. "Articles made mostly by machinery, as many American goods are, will doubtless remain as they are, cheaper than those from abroad, but where much labour is required, as in the case of dynamos, they will probably at first be imported, to some extent at least, until American ingenuity has succeeded in devising cheaper methods of construction. Cheaper raw materials cannot fail to be of benefit to electrical manufacturers who use but do not make them."

These conclusions touch the two sides of the question, and can be fully appreciated in this country.

In relation to the probable importation of some classes of goods, we cannot forbear regretting that the presidential election had not preceded instead of following the application for exhibits at the Chicago Exhibition. Although we drew attention in our issue of July 22nd to the probability of an alteration in the tariff, exhibitors did not seem disposed to count upon it, and, consequently, there was no response to Mr. Preece's suggestion for increasing the number of English electrical exhibits, and we shall, therefore, not make such a good showing in that as in other departments of applied science.

The McKinley tariff has had the effect of scaring the foreign producer, whilst the American people have given evidence of a desire to be rid of it or to reduce its evils. Our contemporary observes the advantage of cheaper raw materials, and this combined with American machine production may go to render English competition on one class of goods more difficult, whilst the reduction in tariff rates will render English competition on another class of goods more easy. We may again refer to our article, in which we advised a discrimination in exhibiting. The exercise of similar discrimination in competition ought to produce a rivalry both friendly and profitable between the two great manufacturing nations of the world.

THE INTERNATIONAL OKONITE COMPANY.

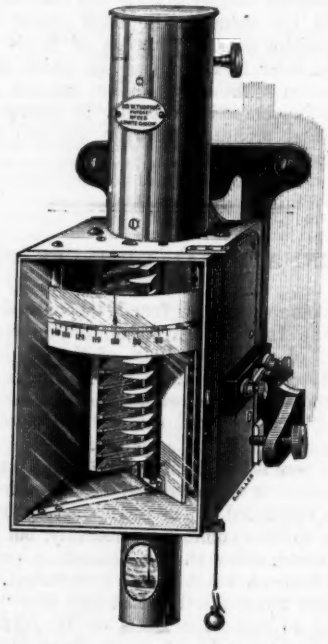
IN another column will be found the annual report and accounts of the International Okonite Company, together with a report of the proceedings of the meeting of shareholders called to consider them. With such a report there can be no surprise that the meeting was of a noisy character, although the directors contemplate the production of a more satisfactory statement at the adjourned meeting on January 10th next. There is ample margin for the introduction of satisfaction, and it is to be hoped that the directors' confidence may be confirmed. The unsatisfactory state of affairs does not seem to have commenced recently, but to date back to a former period, although not noticed in consequence of the sanguine basis on which stocks were valued. The directors say—rather unnecessarily—that had they "felt justified in continuing to value the assets on the former basis, the profits of the year would, of course, have appeared to be much larger than they are," and we hope that, on further investigation, it will be found that the directors have made sufficient sacrifices to ensure that the accounts "start with a real and not a sanguine valuation of assets." In the balance sheet "stock-in-trade," although amounting to £111,872, represents less than one-fourth of the assets. The principal matter referred to in the report is the over-valuation of the American stocks, and the manner in which this has been dealt with in the accounts can hardly be called satisfactory, inasmuch as one item represents the profits of the American business, the depreciation, and the surrender of capital by the managers, "as compensation for excessive valuations of stocks." It would seem that some responsibility is incurred by the excessive valuation of stock, and that responsibility should hardly be compensated for by the surrender of shares, even if the managers and the vendors happen to be the same persons. If the vendors are persuaded that the purchase price was excessive, and make some restitution that is one thing. If the stock has been over valued that is another thing. But the two things ought to be separately dealt with.

The shares surrendered were originally given in part payment of the business acquired, and were valued at par. If the value were taken at the market price at the time of surrender would it amount to the imposing figure of £20,000? The reference in the report to the reorganisation of the Manchester business, and some of the remarks at the meeting, taken together, would seem to point to the internal dissensions which it may be hoped will not be permitted to jeopardise the interests of the general body of shareholders. They have sufficient cause of anxiety in a report which alludes to over-valuation on one side of the Atlantic and a trading loss on the other, and with very little cause of satisfaction in the methods which the directors have adopted to meet their difficulties. Probably stringent measures will be necessary to put affairs in order, and, from the attitude of the shareholders, it would seem that they are prepared to face the situation.

That the shareholders of the International Okonite Company should find occasion for disappointment comes as no surprise to us, as may be seen on reference to our article criticising the prospectus (July 4th, 1890), and we hope that the shareholders at the ensuing meeting will find the directors' explanations more reassuring, and will take measures to place the affairs of the company on a satisfactory business basis.

NOTES.

Lord Kelvin's new form of electrostatic Voltmeter for low Voltages.—The arrangement of the vanes and cells of this instrument are much the same as those of the multicellular voltmeter previously described in these columns.



The instrument is specially designed for use on switchboards, and has a vertical scale instead of the old plan of reading with a mirror. It is rendered practically dead-beat in its action by a small horizontal disc which turns in an oil dashpot below the case. The zero adjustment has been much improved by the addition of a torsion head and micrometer screw.

Kingston-on-Thames Electric Lighting.—At a special meeting of the Kingston-on-Thames Town Council last Thursday, it was resolved to introduce electric lighting into the borough, and to communicate this decision to the Surrey County Council in order that arrangements may be made for the electric lighting of the new county buildings when completed.

Church Electric Lighting.—Two large collieries belonging to the Ocean Colliery Company and hundreds of the workmen's cottages, situated in the upper part of the Rhondda have been for the past few months lighted by electricity. On Sunday last, the Independent and Methodist Chapels were lighted by the current from the collieries, and the work gave entire satisfaction. The Baptist Chapel in the district is also now to be lighted by electricity.

Hull Electric Lighting.—It is expected that the Hull electric lighting station will be completed about Christmas. The committee appointed to carry out the details in connection with the opening ceremony have determined to give the local installing persons, most of whom are agents for the large electrical firms, the opportunity of exhibiting electrical appliances. The exhibition will be held in the Sessions Court, and it will probably be open to the public for five days. The object is to give the public the opportunity of gaining information, and witnessing the advantages of electricity. Messrs. Crompton & Company have also arranged to give an exhibition of cooking by electricity.

Hopkinson v. St. James and Pall Mall Electric Light Company, Limited.—In our report of the case of Hopkinson *v.* St. James's and Pall Mall Electric Light Company, Limited, the account which we give in this number of the proceedings of the seventh day, November 23rd, should have appeared on page 639 of last week's issue before the examination of Prof. Alexander Kennedy, Mr. Mordey, and Mr. Rankin Kennedy.

Torquay and Electric Lighting.—The provisional order for the electric lighting of Taunton expires in July, 1893. Steps are being taken by the Town Council to prevent any other authority stepping in, and the Board of Trade have been communicated with on the matter.

Electric Lighting in Workhouses.—At the meeting of the Thetford Board of Guardians last week the desirability of using the safest possible illuminant in the local workhouse was discussed. The Board decided to obtain estimates for both gas and electric illuminants.

An Electric Tramway at Remscheid.—A tramway is being constructed here on the Thomston-Houston system by the Union Electricity Company. Lightning conductors are to be placed both on the cars and connected with the trolley wires.

Electrical Societies in Germany.—A union or combination of the various electrotechnical societies in Germany is proposed to be formed. A meeting will be held in Berlin in December to consider the matter, when delegates from the various institutions will be present.

Institution of Electrical Engineers.—At last week's general meeting of the Institution the names of new candidates for election into the Institution were announced and ordered to be suspended. Mr. R. A. Smith and Mr. Girdlestone were appointed scrutineers of the ballot. Donations to the library were announced as having been received since the last meeting from the Astronomer Royal, the Director-General of Telegraphs in India, Mr. John Aylmer, local hon. sec. in Paris; Dr. John Hopkinson, F.R.S., past president; and Mr. Perren Maycock, member, to whom the thanks of the meeting were accorded. The following paper was then read, "Experimental Researches on Alternating Current Transformers," by Prof. Fleming, D.Sc., member. A ballot for new members took place, at which the following candidates were elected :—Associates (3)—Epstein, L., Cadby Hall Works, Hammersmith; Guy, George Heli, Temple Court, New York, U.S.A.; Moir, William, 74, Commercial Street, Dundee, N.B. Student (1)—Warden-Stevens, Frederic Joseph, Manor Lodge, Brockley, S.E. Last evening (December 1st) there was a discussion on Prof. J. A. Fleming's paper on "Experimental Researches on Alternate Current Transformers."

A students' meeting will be held at 28, Victoria Street, at 8 p.m., on Friday, December 9th, when Mr. E. S. Franklin will read a paper on "Electric Light Cables."

Train Lighting.—As we have before stated, the electrically-lighted trains on the London, Brighton and South Coast Railway are giving such satisfaction that the directors of the company have ordered seven additional trains to be equipped, making 30 trains in all. It is found, in practice, that the electrically-lighted trains meet the requirements of railway working better than gas trains, inasmuch as they are always ready to go anywhere at any time; whilst the others must, frequently at inconvenience and delay to the traffic, be sent periodically to the charging stations for the purpose of having their gas cylinders replenished, thereby entailing additional expense for haulage and loss of time.

Society of Arts.—At the third ordinary meeting of this society, held on Wednesday evening, November 30th, a paper on "The Copper Resources of the United States" was read by James Douglas. The chair was taken by Sir Lowthian Bell, Bart., F.R.S.

Electric Traction in Dortmund.—The tramways in this town are to be shortly worked by electricity. The company is to pay to the town for the concession 2 per cent. of the gross receipts.

Electric Motors in Cologne.—The members of the Cologne Electrotechnical Society visited the central station in that town on November 22nd. They subsequently inspected the new port works with special reference to the use of electromotors for operating circular saws and pumps. One pump is situated at a distance of 1,000 metres from the generating station, where, it will be remembered, continuous current dynamos are installed.

Telephony Between Frankfort and Berlin.—It is intended to establish telephonic communication between Frankfort-on-the-Main and Berlin. It is said that two wires will be arranged for direct communication between both towns and two others for the intermediate towns of Giessen, Cassel, &c. According to the scheme, the direct lines are to be in operation at the commencement of next year.

The Frankfort-Offenbach Tramway.—According to the report for 1891-92 of the Frankfort-Offenbach Tramway Company, the cars conveyed 1,042,920 persons, as compared with 1,034,562 in the previous year. This increase refers to passengers carried short distances, whilst the number of "all-the-way" fares diminished. The gross receipts (those for the previous year being given in parenthesis), amounted to £6,996 (£6,975), the working expenses to £5,202 (£5,121), interest to £132 (£193), and depreciation to £1,110 (£1,109). This leaves a net profit of £552, as against £539 last financial year, and allows of a dividend of 1½ per cent., the same as in 1890-91, and of the placing of a little to the reserve and redemption funds.

Dundee Electric Lighting.—At a meeting of the Dundee Property Committee last week it was agreed after deliberation to fit up the town hall, the guild hall, and the contiguous town offices with the electric light, it being the opinion of the meeting that the Town Council should be the first to lead the way in adopting the new illuminant.

The Institution.—Referring to our article on the Institution of Electrical Engineers, *Lightning* says: "It is strange how little the writer of this and of another article in the same number seems to be in touch with the craft." We do not, of course, know in what manner our contemporary intends the expression "in touch" to be taken; but if being perfectly well acquainted with the feelings of those of the community who have on more than one occasion replied to circular letters sent to each and every member by the secretary, asking for their opinions on matters connected with the conduct of the Institution, then we must plead that we are in touch with the craft, and still contend that the "two extreme sections" are more imaginary than real. The Institution is not solely composed of Whitehall Club *habitués*, Faraday House students, or House-to-House Company's officials. As for the "crass ignorance" displayed by the REVIEW in commenting upon the death of Thomas Lang, the uncontradicted evidence of David Jones was to the effect that the current was turned off from 11 in the morning till 3 o'clock in the afternoon. Clearly Dr. Oliver Lodge might still do useful work by investigating the newest form of *Lightning*.

Manchester Association of Engineers.—A meeting of this Society was held on Saturday last, for the purpose of discussing the paper read by Mr. B. H. Thwaite, on "Electric Power Transmission from the Coal Field." Subsequently, a most interesting demonstration of the vitilising influence of the actinic or chemically active and refrangible rays emitted from the electric light on organic plant life, was given by Mr. Thwaite.

Cambridge Electric Lighting.—During the past week the recently-established electric lighting company at Cambridge turned on their current for the first time. Nearly all the shops in Trinity Street, and some others elsewhere, have already adopted it, and it is also being used in several of the colleges.

Royal Society Anniversary.—The anniversary meeting of the Royal Society was held at Burlington House on Wednesday last. Some preliminary business having been gone through, Lord Kelvin delivered his address. He commenced by referring to the losses the Society had sustained during the year through the deaths of a number of scientists. The chief portion of the address was devoted to the subject of terrestrial magnetic storms. At the conclusion of his remarks the medals were presented, and the Society elected officers and council for the ensuing year. In the evening the anniversary dinner was held at the Hotel Métropole.

Personal.—Mr. G. G. Ward, the Vice-President of the Commercial Cable Company, after an absence from America of about six months, returned from Europe not long since. Mr. and Mrs. Ward, says the *Electrical Engineer*, were compelled by circumstances to spend the twenty-fifth anniversary of their marriage on the ss. *City of Paris* in mid-Atlantic, but they were not forgotten by their friends and admirers in the Commercial Cable Company, who, a few days after their return home, surprised them overwhelmingly by the presentation of a silver dessert service. It is an exceedingly handsome set, made and engraved by Tiffany.

The French Atlantic Cable Company.—The *Financial Times*, of Wednesday last, had the following:—"With regard to a rumour published to the effect that a consolidation of all the cable companies outside the Western Union had been arranged, and that Mr. Bennett, of the *New York Herald*, and Mr. Pulitzer, of the *New York World*, had bought control of the French Cable Company, Dalziel's Cable Agency is authorised to announce that no such arrangement has been entered into, and that no one is in a position to control the French Cable Company."

Society of Arts.—On Wednesday, December 7th, a paper on "The Chicago Exhibition, 1893," will be read by James Dredge. Sir Philip Cunliffe-Owen, K.C.B., K.C.M.G., C.I.E., will preside.

The Electric Light at Brighton.—The electric lighting of Hove (Brighton) was inaugurated on Monday last at Hove Town Hall, in the presence of a large and influential gathering, presided over by Mr. Woodruff, J.P., chairman of the Hove Commissioners, which body has transferred the powers obtained under a provisional order for lighting the town by electricity to the Hove Electric Lighting Company, Limited. The formal switching on of the current was performed by Lady Louise Loder, who was presented by the chairman and directors of the company with a silver paper knife as a memento of the occasion.

Bromley and Electric Lighting.—A movement in the direction of electric lighting is being made in Bromley, the Board having asked those willing to take up the new light to notify their intention on forms provided.

Ramsgate and Electric Lighting.—The Town Clerk at Ramsgate has been instructed to inform the Municipal Electric Lighting Company that the Corporation would oppose the proposed Bill of the company.

Factory Electric Lighting.—Messrs. George Roberts and Co., of Selkirk, have just had the electric light introduced into their woollen factory, and have wholly dispensed with the use of gas. In the works there are over 500 lights. Contracts have also been arranged by Mr. Strang Steele for having the electric light introduced into the Mansion House, &c., on his estate of Philliphaugh.

NEW COMPANIES REGISTERED.

Arcas Plating Company, Limited.—Capital £80,000, divided into 80,000 shares of £1 each, to purchase or otherwise acquire any patents, brevets and inventions, licenses, concessions and the like, conferring an exclusive, non-exclusive or limited right to use any invention which may seem to the company capable of being profitably dealt with; to adopt and carry into effect, with or without modification, an agreement dated November 15th, 1892, and made between the London Metallurgical Company, Limited (and Sherard Osborn Cooper Coles), thereinafter called the vendors, of the one part, and Harold Read Braid, for and on behalf of the company, of the other part. The subscribers (with 1 share each) are: J. A. O. H. Webster, West Kilburn, accountant; M. Silber, Piccadilly, gentleman; H. R. Braid, Chiswick, electrical engineer; A. G. Webber, Brixton, solicitor's clerk; D. Houstam, West Norwood, gentleman; F. May, Queen's Park, W., clerk; G. R. Grant, 141, Norfolk Street, W., solicitor. The number of directors is not to be less than

four, nor more than seven. Qualification, £100. Remuneration to be fixed by the company in general meeting. Registered on the 22nd ult. by Messrs. Jordan & Son, 120, Chancery Lane, W.C.

Automatic Electric Railway Signal Company, Limited.—Capital £10,000, divided into 10,000 shares of £1 each. Objects: To acquire patents and apparatus for railway signalling, and articles of a similar nature appertaining thereto; to enter into a certain agreement duly specified, and to establish and work automatic electric signals for railways, and grant licenses to establish and work the same. The subscribers (with one share each) are: J. Bushley, Liverpool, general broker; R. Brown, Liverpool, cotton broker; W. H. Potter, Liverpool, shipbuilder; F. F. Loftus, Liverpool; J. Charnley, Liverpool, hemp broker; R. B. Annesley, general broker; E. R. Leyland, shipowner. With certain modifications, the regulations of Table A apply. Registered on the 26th ult. by Wynne, Holme and Wynne, 40, Chancery Lane, W.C., solicitors.

Glauber-Ferrite Syndicate, Limited. — Capital of £25,000 divided into 2,500 shares of £10 each. To carry on the business of glauber-ferrite manufacturers, and of plant, machinery and materials therefor either as principals or agents, and especially in relation to dealing with inventions and letters patent or rights therein, to carry on the business of civil, mechanical and electrical engineers, or any other business in connection with any invention or processes in which the company may be interested. The subscribers (with one share each) are F. H. Haynes, 93, Stockwell Park Road, S.W., auctioneer; Wm. Jos. Robins, 65, College Street, Highbury, N., draughtsman; M. Howard, Radcliffe Square, Middlesex, engineer; H. C. Hannington, 95, Farringdon Street, E.C., accountant; F. E. Hancock, 7, Smith Square, S.W., no occupation; J. Birchell, N. Finchley, solicitor's clerk; J. Semper, 16, Shaftesbury Avenue, contractor. The number of directors is not to be less than three nor more than nine, exclusive of a managing director. Qualification £500. Remuneration £150 per annum for each director and £100 per annum extra for the chairman. Registered by Baker, Blaker & Hawes, 117, Cannon Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Sunderland and District Electricity Company, Limited.—Messrs. Pinkney and Bolom have communicated to the Registrar of Joint Stock Companies to the effect that nothing has been done in regard to the above company since its registration, and that no business has been done.

Association for the Protection of Telephone Subscribers, Limited.—The registered office of this company is situated at 58, Coleman Street, E.C.

Hope-Jones Electric Organ Company, Limited.—The registered offices of this company are situated at 4, Huggin Lane, Queen Victoria Street, E.C.

Universal Arc Lamp Syndicate, Limited.—A notice has been filed at Somerset House stating that the registered office of this company is situated at 66, Berners Street, W.

CONTRACTS OPEN AND CLOSED.

OPEN.

York.—December 6th. For the following articles during six months ending June 30th, 1893, delivered carriage paid at the telegraph stores at York, for the North-Eastern Railway Company: 1. Telegraph apparatus. 2. Telegraph wire and line stores. Forms of tender may be obtained on application to Mr. Graves, telegraph department, York, and tenders must be sent to Mr. C. N. Wilkinson, secretary, York, sealed and marked "Tender for telegraph stores," by noon on December 6th.

Belfast.—December 12th. The Belfast Harbour Commissioners are inviting tenders for the electric lighting of Queen's Quay, Abercorn Basin, and the Hamilton Graving Dock. For further information, see our advertisement pages.

BUSINESS NOTICES, &c.

Electric Lighting at the Great Northern Victoria Hotel, Bradford.—This installation consists of about 600 lights of 32, 16, and 8 C.P. fed from the Corporation supply at 115 volts. The wiring of the hotel is carried out entirely on the sub-circuit distribution plan. Two pairs of heavy main cables are carried up the side of the hoist, and from these are run branch cables to the distributing boards on each floor. On these distributing boards are fixed the double-pole sub-circuit cut-outs of 10 ampères each. The casings to carry the wires to the various rooms are run on the corridor walls on the underside of the mouldings, and are hardly noticeable. When a branch wire is taken through a wall to a bedroom, a fuse is fixed in the casing in the corridor, and the wires in the bedrooms are carried in casing on which an ornamental picture mould is screwed, 18 inches from the ceiling, forming the limit of the frieze. A small bent bracket, 18 inches projection, is fixed to the said picture mould, from which drops a suspension fitting with lamp and shade. The lighting of the reception rooms, coffee room, reading and writing rooms, &c., is all by means of highly ornamental electroliers, brackets, and table lamps designed to suit the requirements of each respective room. The passenger lift has a light inside that travels with it, the connection being made by a flexible wire and counterweight. The lavatories are all fitted with a specially designed switch which puts on the light automatically when the door is bolted. Electric bells are fitted throughout with a new design of semaphore fixed outside each door. When the button in the room is pressed, a red flag drops out of a slot in the semaphore box to indicate to the servant where the call comes from without necessiting a journey to the indicator. The flag is replaced by hand when the call is answered. Telephones connect from a multiple switchboard in the manager's office, to various departments. Speaking tubes are fitted to all service rooms with call bells, &c. The passenger hoist has also an indicator and bell fixed inside, connected by means of a cable with five insulated strands running over pulleys and fitted with counterweight, which can be operated by pushes fixed on the various floors. The whole of the installation was caried out by Messrs. Woodhouse & Rawson United, Limited, from their branch at 41, Piccadilly, Bradford, Yorks.

Personal.—Mr. J. B. Braithwaite, jun., having been elected chairman of the Brush Electrical Engineering Company, Limited, in succession to the late Duke of Marlborough, has accepted the appointment for the period of one year.

We understand that Mr. Alfred Slatter, Assoc. M.I.E.E., has retired from the Planet Electrical Engineering Company, Limited, and besides several consulting appointments, has joined the firm of Messrs. Julius Sax & Co., of Central Markets, Smithfield, E.C., and Ridgmount Street, W.C., as their manager. We wish Mr. Slatter every success in his new venture.

Mr. E. G. Tumber has resigned the position of general manager to the Electric Stores, Limited.

We hear that Mr. F. Dagger has resigned his position as superintendent of the Plymouth district for the National Telephone Company, and his connection with the company will cease on December 28th. Mr. Dagger entered the telephone service eleven years ago, having served four years with the Lancashire and Cheshire Telephonic Company, in North-east Lancashire, four years with the Western Counties and South Wales Telephone Company, at their head offices in Bristol, and three years as superintendent of the Plymouth district.

Auction Sales.—Messrs. Wheatley Kirk, Price and Goulty have sent us a catalogue of the steam boilers, engines, machinery, and other effects upon the premises of the Springfield Works, Basford, and the Queen's Road Works, Nottingham, lately the property of Lindley Wright & Cox, Limited, which company is now in liquidation, and which effects were offered for sale by public auction on Tuesday and Wednesday last on the works' premises.

Twickenham and Electric Lighting.—At a recent meeting of the Twickenham Local Board, the Electric Lighting Committee reported that at their meeting on November 17th, Mr. Goode, representative of Messrs. Hammond & Co., attended and explained his proposal for lighting the parish by electricity, and his offer to submit, free of charge, an estimate of the cost of his scheme was accepted by the committee.

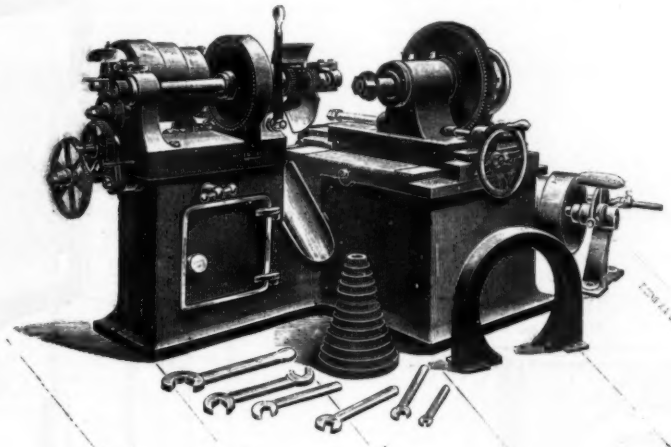
Private Lighting at Dundee.—Messrs. Lowdon Brothers, electrical engineers, Dundee, have secured a contract for lighting Eden Valley Works, Freuchie (Messrs. William Lumsden & Son), by electricity. The installation will consist of 100 16-candle lamps, the motive power will be a Shanks engine, and the electrical supply will be generated by an Elwell-Parker dynamo.

Laurence, Scott & Co.—The Ipswich branch of Messrs. Laurence, Scott & Co. has, during the year, been handed over to the Ipswich Electricity Supply Company. Up to the present, however, no alteration has been made in the working from that of previous years. It is expected that a larger station will be at work early in the new year.

Toynbee Hall Electrical Society.—We hear that Mr. R. W. Paul, of 44, Hatton Garden, has kindly presented the members of this society with one of his latest pattern Ayrton-Mather reflecting galvanometers (D'Arsonval type) for use in the society's laboratory at 34, Commercial Street, E.

Smoking Concert.—The London employés of Messrs. Drake & Gorham, numbering upwards of 100, held their first smoking concert on Wednesday last, when considerable musical talent was shown. The programme included both instrumental and vocal music, and a most enjoyable evening was spent.

New Circular Milling Machine.—The following is a description of a new circular milling machine manufactured by Messrs. Ludw. Loewe & Co. The machine is designed to take the place of the lathe for various turning operations, and finishes at one cut any circular surface which can be produced by milling cutters. It can be used for finishing gear wheels, grooved pulleys, flanged pulleys, pulleys with crowning face, rope pulleys, rolls, hand wheels, balance wheels, &c. In many cases it produces work cheaper than turning by 50 per cent. to 75 per cent, as five or six of these tools can be attended by one unskilled operator, and they will do the work of double that number of lathes. The cutter spindle is driven through back gears by a powerful belt, and the outer end of the cutter arbor is supported by an adjustable tail stock. The head, which carries the part to be milled, is very solidly constructed, and is adjustable in both directions horizontally, so it can be quickly set



for different cuts, and it is firmly locked in place while the cut is being made. It is provided with adjustable stops. The circular feed of the working spindle, which is 2⅛ inches in diameter, is driven by a worm which works into a large worm gear fastened directly to the spindle. This gives a steady powerful feed. The feed is variable through a set of change gears, and the whole machine can be stopped automatically at any desired point. The bed is cast in one piece, with the inside arranged as a tool box. All the parts are thoroughly protected from dust. A set of change gears, necessary wrenches and countershaft are furnished with each machine. This size mills parts from 4 inches to 22 inches in diameter.

Mill Lighting.—The Electrical Engineering Company of Ireland, Limited, have recently carried out a contract for the York Street Flax Spinning Company, Limited, Belfast, this being the first trial in these mills of using electric light over the looms. So very satisfactory and beneficial has been the trial that it is proposed to considerably extend the plant. A Crompton dynamo is at present used, and, although the output is in excess of the normal, it runs 58 hours a week practically without attention. This firm have also completed a large contract for Messrs. Clery & Co., Sackville Street, 18 Brockie-Pell arc lamps and 50 incandescent lamps being installed, current being taken from the Corporation alternate current mains. Among other people who have placed contracts with this firm, we might mention the Patriotic Assurance Company, the Guardian Assurance Company, the Alliance Assurance Company, Stephen's Green Club, the City and County Conservative Club, Hotel Métropole, Hammann Hotel, Morrison's Hotel, Burlington Hotel, Gaiety Theatre, Star Theatre. In construction work they have recently built for Messrs. Lafayette & Company, the well-known photographers, a photographic arc lamp which absorbs 120 ampères and gives an illumination of about 15,000 candle-power. It is put in a parabolic reflector, is automatic in action, has hydraulic raising and lowering gear, and has given every possible satisfaction. It is used at their Manchester house.

Epstein Accumulators.—We understand that the Epstein Electric Accumulator Company, Limited, have received an additional order from the Birmingham Central Tramways Company, for six sets of their accumulators, each set consisting of 96 cells of type T 9. The first five sets supplied by them have now been in regular use during three months, and the satisfactory results obtained prove conclusively the efficiency of their cells for traction work, and further that the very low rate at which they have undertaken their maintenance is as advantageous to the Tramway Company, as it is profitable to the suppliers. With this important point of the upkeep of Epstein batteries demonstrated beyond doubt, showing the working to be less costly than that of an overhead wire system, tramway companies contemplating electric traction should have no difficulty in deciding which system to adopt. These facts, the outcome of actual experience need only be known to ensure for accumulator traction the favour, which, with its many acknowledged other advantages, it merits.—We have received a proof of a very useful pamphlet in which the working by the trolley system and that of self-contained cars fitted with Epstein accumulators are contrasted.

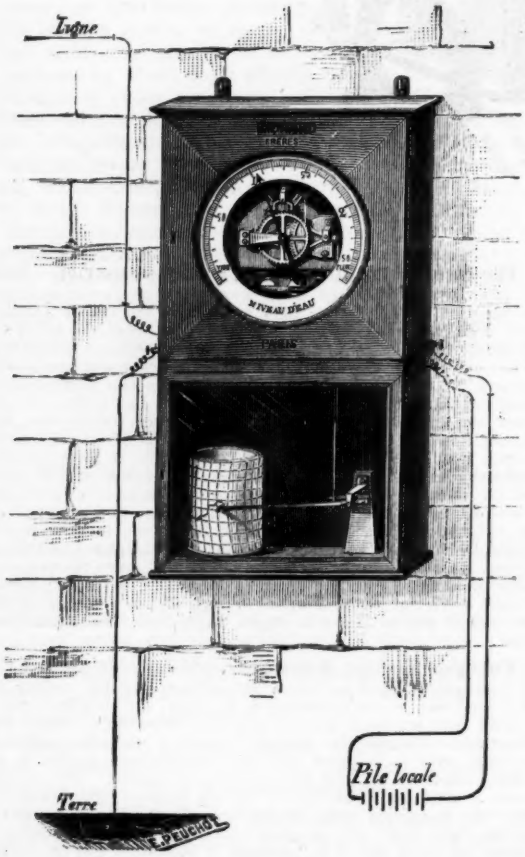
New Catalogues.—We have received a copy of a neat little catalogue of electrical engineering apparatus from the Newton Electrical Engineering Works, of Taunton. The new style of binding, allowing addition of further lists, has been adopted, and good paper is used, the printing also being of the first order. The Taunton dynamos are very nicely illustrated, as is also the combined Taunton dynamo and oil engine. The following machines, &c., are also described: Tramcar or launch motor, Newton-Hawkin's patent brush holders, automatic switch of both the hanging and table types, compound charge and discharge accumulator switch, Newton-Hawkin's swinging switchboards, Newton arc lamps, alternating current transformer, and E.P.S. accumulators. The Taunton dynamo, however, forms the chief feature in the catalogue, and in reference to this there is given a full page illustration, showing the Kapp armature. Prices of the various apparatus are given.

The Electric Light in the St. Pancras District.—Since our last visit to this district, great progress has been made as regards the adoption of the electric light, and a large number of contracts have been completed, amongst which we may mention one in the premises of W. J. Hann, the Whittington Restaurant, Hampstead Road; one in the premises of Mr. W. Smith, boot and shoe manufacturer, 276, Euston Road; one in the Orange Tree Hotel, Euston Road; one in the premises of Messrs. Hey & Co., hatters, Euston Road; one in the premises of Mr. M. S. Lesser, watchmaker, 301, Euston Road; one in the premises of Mr. T. D. Woodhouse, tailor, Euston Road; one in the premises of Messrs. A. H. Hartson & Co., stationers, Euston Road; one in the premises of Messrs. S. E. Beere and Co., chemists, Hampstead Road; one in the premises of Messrs. White & Co., oyster salesmen, Euston Road; one in the premises of Mr. J. Lock, optician, Tottenham Court Road; one in the premises of Mr. D. McGregor, boot and shoe maker, Tottenham Court Road. Messrs. Vaughan & Brown, of Kirby Street, E.C., have recently completed work in the Blue Posts Hotel, Tottenham Court Road; Messrs. Woods & Co., of Great Portland Street, W., are fitting up the premises of Messrs Harris & Marks, tailors, 216, Tottenham Court Road.

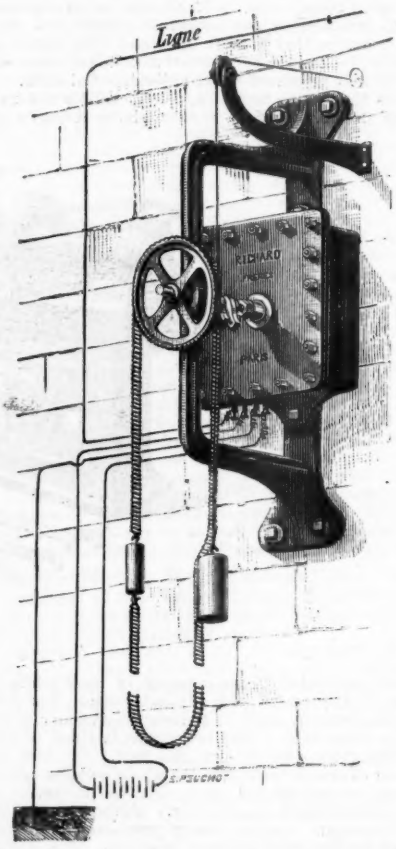
Portable Testing Apparatus.—Messrs. Muirhead & Co., of Westminster, have sent us a list of their portable testing set. This has been specially designed to meet the requirements of electric light engineers, and consists of a Wheatstone bridge, with adjustable resistances for testing copper, or conductor resistance, together with a constant coil of 10,000 ohms resistance for testing insulation by the direct deflection method. The galvanometer is fixed inside the lid of the box and is connected to the terminals, to which a series of shunts ($\frac{1}{2}$, $\frac{1}{10}$, $\frac{1}{100}$) is also connected. On the right hand side is a key which puts the galvanometer in circuit for either the C R., constant, or insulation test as desired. The contacts of the bridge, the resistance coils and the shunt are sliding contacts, thus doing away with all loose plugs; the advantage of this and the great facility with which the tests can be made will be obvious to inspectors and others who have to make rapid tests under all manner of conditions and adverse circumstances. All the internal connections of the instrument are so plainly engraved on the ebonite top that the set can be used by an ordinary wireman without the help of written instructions.

Private Installations.—Messrs. Bergtheil & Young, of 13, Walbrook, E.C., are at present very busy with electric lighting work. Some of the contracts they have in hand are as follows. For Messrs. A. & G. Taylor, the Victoria Printing Works, 118, Stanstead Road, Forest Hill, a complete plant consisting of an Elwell-Parker 9-unit dynamo and Premier gas engine. The London Corn and Forage Company, Mile End Road, complete plant, consisting of an Elwell-Parker 8-unit dynamo and Premier gas engine, and the premises of Messrs. Hicks & Co., Mile End Road, Messrs. Victory and Co., Regent Street, Messrs. Kino Brothers, Westbourne Grove, the Duchy of Lancaster Offices, Lancaster Place, W.C., and the residence of J. H. Potter, Esq., 71, Linden Gardens, is being wired.

Long Distance Liquid Level.—The Corlett Electrical Engineering Company, Limited, of Wigan and Bolton, have lately completed a very useful electrical contrivance at the Wigan Waterworks, which enables the engineer in the pumping engine house to see at a glance what height of water he has in the supply reservoir. The apparatus consists of two separate parts, viz., the transmitter and the receiver. The transmitter is fixed in the high level reservoir, and consists of a cast-iron circular box about 6 inches in diameter, made as far as possible damp proof. A spindle working in gun metal bearings is taken through the case, but projecting about 2 inches on the face. This projection carries a toothed wheel, over which runs a specially constructed strong chain. On one end of this chain a float is fastened, which rests on the water and rises and falls with it. At the other end of the chain a compensating weight is fastened. Inside the iron case an ingenious three segment commutator is fixed to the spindle and revolves with it. A fixed brush or collecting spring bears lightly on the commutator. It will be seen that as the water falls or increases in height the float will cause the toothed wheel to turn to the right or to the left as the case may be. One wire is taken from each of the three segments of the commutator overhead on suitable poles to the pumping house, where apparatus No. 2 is fixed. This part of the apparatus is a very ingenious and beautiful piece of work. It really consists of two parts, the recording portion and the dial indicator. The dial portion has three main line electro-magnets, and a fourth acting as a break or locking coil. These coils are fixed in a circle, and are acted on by a number of cells placed near the apparatus, which are always ready for action. The lines from the transmitter are joined to the coils of the electro-magnets corresponding to the segments on the commutator. The armatures of the main



line electro-magnets are bearing with V-shaped points into a cylinder with V-shaped cuts. The cylinder is fixed to a small spindle. The fourth or locking coil armature drops into a slotted wheel, which keeps all the parts steady when not in action, and also prevents the dial needle indicating more than 1 inch rise or fall at one time. The needle or pointer is geared to the small spindle actuated by the electro-magnets; the battery being always connected to the electro-magnets, the one must be acted on which corresponds with the segment on which the collecting brushes rest in the transmitter. This movement of the armature forces the V-shaped piece into the cylinder and causes the small spindle to be pulled round slightly, carrying the needle or pointer with it, and marking one division on the dial, or 1 inch of water. The dial resembles the face of a clock, but is marked in feet from 0 to 8. The space between the feet is marked in inches. Now if these electro-magnets are acted on by the current one after the other in the same direction, that is, if the transmitter wheel is turned in the same direction, it must pull the dial pointer round with it in the same manner. If the direction of rotation is reversed, the coils will act backwards, pulling the needle backwards. The recording apparatus consists of a clock, enclosed in a brass tube 4 inches diameter by 6 inches deep, working on a geared spindle, the clockwork causing the tube to revolve once in every 24 hours. A graduated paper, divided vertically in hour divisions, and horizontally in inch divisions, is easily clamped on this tube. A pen, mounted on a long fine steel spring arm, bears on the graduated paper. The spring arm is attached to a beautifully arranged system of levers, which are geared to the spindle carrying the pointer. These levers are so arranged that when the needle or pointer registers



on the dial, the pen bearing on the graduated papers is lifted one division higher. When the needle falls the pen is dropped in the same manner, and as the pen is always marking, and the cylinder carrying the paper is always slowly revolving, an irregular line is described on the paper. This line will be more or less irregular according to the variations in the head of water. The work was carried out under the personal supervision of Mr. J. E. Pullin, of the Corlett Electrical Engineering Company, Limited, and is giving the greatest satisfaction. It is certainly one of the most useful electrical appliances that this enterprising firm have dealt with. The instrument is Messrs. Richard Frères's long distance Self-Recording Water Level, as described in their catalogue.

The Electric Light in the West End.—Since our last report we find that a large amount of new work is in hand. Among the new contracts which have recently been completed, or are at present being carried out, we may mention one in the offices of the *Colliery Guardian*, Essex Street, Strand. Electric lighting has also been introduced into the studio of Messrs. Vaus & Crampton, Limited, zinco-process engravers, Savoy House, Strand. An installation is being carried out in the premises of Mr. A. J. Wolf, watchmaker and jeweller, 8, Charing Cross. Contracts have recently been carried out at 38 and 39, Parliament Street, and at the offices of the Commercial Cable Company, Northumberland Avenue. Quite a large number of contracts have recently been executed in the Strand, among which may be mentioned those in the premises of the National Silex Optical Company; Messrs. Sidney Charles & Co., hosiers, &c.; Messrs. Crabb & Parry, tailors; Mr. C. Millinger, umbrella maker; and Mr. J. C. Kino, tailor.

The Electric Lighting in the City.—A large amount of new work is noticeable round the City. The Brush Electrical Engineering Company are carrying out a contract in the extensive premises of Messrs. Waterlow & Sons, Limited, printers, &c., 26 & 27, Great Winchester Street.—A contract is at present being carried out in the London offices in Great Winchester Street of the Bank of Constantinople. The work is in the hands of Messrs. Crompton and Co., Limited, Mansion House Buildings.—Messrs. Laing, Wharton and Down, of New Bond Street, are engaged upon the premises of Messrs. Sharp & Wilkins, also in Great Winchester Street.—A contract has recently been carried out in the Rendezvous Wine Rooms, Union Court, Old Broad Street.—Messrs. Paterson & Cooper, of Victoria Street, Westminster, are engaged in some new premises in Wormwood Street.—Work has also been completed in the premises of Messrs. Fitch & Son, provision dealers, Bishopsgate Street Within.

CITY NOTES.

Swan United Electric Light Company, Limited.

THE tenth ordinary general meeting of this company was held on Tuesday last at Cannon Street Hotel, Mr. J. S. Forbes presiding.

The SECRETARY, having read the notice convening the meeting,

The CHAIRMAN said he would begin with the profit and loss account, because in explaining the items he would probably answer in anticipation questions which might otherwise be put. First of all they would see that the sales, less commission and allowances, were £9,498 1s. 8d., and in the corresponding period that item amounted to £15,348 11s. 10d. At first sight that was, of course, rather disturbing, the sales diminishing in one year from £15,348 to £9,498 looked bad until it was explained. The fact was, that that year they had a special sale of 100,000 lamps for Australia at a very fair price, and that came into the account to which he referred. Those lamps had been manufactured, and formed part of a large stock, and then that fortunate opportunity occurred to sell them in a block. If they took the realised price of those lamps to be close upon £10,000, they would see that the sales of lamps on the "local" business, so to speak, of the Swan Company, was about £5,348, and therefore, bearing that in mind, the local business—regular business—had increased from about £5,000 to £9,498; in fact, was nearly doubled. In transfer fees and interest there was a slight diminution, £1,168 against £1,290; people apparently had not been so anxious to transfer their interest in the company. The interest account was a small item, but in that company all small items had to be borne in mind. The dividends on shares in the French Company amounted to £1,466 11s. 6d. against £1,178 6s. 2d. This year that company found themselves able to pay 5 per cent. as against 4 per cent. in the preceding year, and he was able to say, incidentally, that notwithstanding the competition in France, which had set in more earnestly, he thought the current year might show certainly as good a dividend, and probably a larger one; that seemed to be the opinion of their French colleagues. Dividends on shares in the Edison-Swan Company £37,094 15s. 8d., as against £34,799 11s. 6d.; that advance arose from the Edison-Swan Company on distribution of the last year being able to pay a rather larger dividend, and, of course, as the Swan Company held a very large share of that total capital in the investment of the Edison-Swan, they participated in that improvement in the position. That stock was a matter of some moment, because on the question of that stock depended the final balance of the account, and he thought when they understood it they would see that the reason why they had paid—or proposed, with the shareholders' permission to pay, 1 per cent. less than the correspondyear—was that they had so dealt with the stock as to make their position sounder. The stock brought forward last year was £18,449 value, which they had diminished to £14,600, a difference of about £3,800. If they had left the stock in the bags they would have had £3,800 more to divide, but he would refer to that when he told them why they thought it right to reduce the value of the stock. He next referred to purchases. Purchases meant raw material worked up at the factory into lamps. General charges, including all those varieties of things, salaries, directors' fees, income-tax, general and law charges, amounted to £3,620; wages and expenses at the factory, £6,637. Sales ledger reserve £300, which item they reserved to cover the risk of all debts. They found, however, that sum was quite a sufficient margin. In the purchases, the item, platinum, was one of the elements, and platinum during the last two or three years had been a very errant quantity. In both the Edison-Swan and the Swan Company they were forewarned by competent judges that they would be wise to lay in a considerable stock, for whereas the output of platinum, chiefly in Russia, was a very limited quantity, and in the hands of a ring of two—certainly not more than three—powers, the consumption of platinum, owing to the extension of electric lighting, and oddly enough, to an improved deal on the part of the American dentists, was enormously increasing. He was somewhat surprised to find that the chief competitor to the electric lamp manufacturer now, was the American dentist; he could easily understand that in the particular article in which they dealt, continuity of life and indestructibility might be as valuable as it was in their lamps. However, the Swan Company bought in advance upon the best advice they could get, and according to the best of their judgment, a considerable quantity of platinum, and though in the case of the Edison and Swan Company they were fortunate enough to consume the greater part before a fall in price set in, that was not the case with this company. Having, therefore, bought the metal at an average of 60s., they could now obtain it at an average of about 30s. That being the case, the board thought it wise to write this down one-half, and should the metal rise in value, it might be prudent to write it up again. From the necessities of the business, the company had a very large number of lamps in stock, and something like 320,000 lamps meant a considerable amount of money locked up. In Germany there had been severe competition in this lamp business, which had also been the case in France, and which he believed would happen in England sooner or later. The lamps had, therefore, been written down from 9d. to 8d., and a penny on 320,000 lamps was an appreciable quantity. These two items, and some other matters of less moment, accounted for the item of stock, which had been brought forward as £18,499, being written down to £14,654. The board had considered it more prudent to do this than to pay a dividend of 11 per cent., as was done last year; so that the balance-sheet had been put on a sounder footing, and brought into line with the circumstance of the moment. In the production of a lamp, platinum at 60s. meant 2½d., and at 30s. only 1¼d. With a greater quantity the less was the cost of production, and in the result that must be the proof. In Germany there were at present three companies with resources and intelligence enough to carry on this lamp business; but the universal opinion there was that the lamps manufactured by this company were certainly as good as, and probably better than, those of their competitors—Messrs. Siemens & Halske and another company—who had bought from Mr. Edison the patents for Europe, which the Swan Company purchased for Great Britain. The German Edison Company were not only makers of lamps, but also large installers of electrical stations. Many small lamp factories, too, had been started, and the three great companies, having appreciated the position, had determined to kill the little lamp makers. Thus the survival of the fittest was going on in Germany, and he believed the result would be efficacious, so that the price of the lamp, which was now very low, might be so regulated as to produce better results. That was why the accounts of the sales showed a less favourable result than they would have shown had the prices been equal to those of corresponding period. It would not do to sit still and be pushed out of existence, so that they were now playing the amiable game of trying to survive, and he believed they would succeed. Another feature was that, with the lower price of the lamp, the relative consumption would probably grow. To the company it might, in the long run, be a matter of indifference whether they sold three lamps at 9d. each or one lamp at 2s. 6d., as the profit was determined by the quantity produced. By doubling the present quantity they might probably produce the lamp at 2d. less than the present price. The mere ear-marked quantity was easily obtainable, being greatly influenced by the rent, wages, and all those charges which were relatively high to a small number, but relatively low to a large production. Therefore, from the view taken by the directors, subject to this general expansion, and though some shareholders by their letters showed they were a little disquieted at the reduction of dividend, he believed that the position of the company was really sounder than it was last year. The balance of profit and loss account was £34,840, as against £39,000 in the corresponding half-year, or about £4,000 less; but the latter balance contained the valuation of stock in hand, stated at £18,449, as compared with the present valuation of £14,654. That went a long way to account for the difference, and he thought he had sufficiently explained the matter, although he would be prepared to give any detailed information or to discuss the question further. Now, in dealing with the balance of £34,840, the board proposed to distribute it, retaining at the same time a reasonable reserve. The directors had carried forward a balance of £8,010 from the last account, foreseeing this question of price, and that the rectification of the balance-sheet was imminent. The total disposable amount was, therefore, £42,850, and of this an interim dividend at the rate of 8 per cent. had been distributed in respect of the first half-year, leaving for distribution a further dividend at the rate of 12 per cent. for the half-year, or a total dividend for the year at the rate of 10 per cent., enabling an amount of about £6,000 to be carried forward. The share capital stood, as it had for several years, at £375,071. The item of forfeited shares had disappeared from the balance-sheet, and the cost of patent rights had been thus written down from £332,449 to £328,563. With respect to the item of outlay on factory, plant, &c., the company had a factory in Germany, and, in order to make it efficient, they had spent £12,000 or £13,000 upon it, which had now been written down to £1,570. The remaining items in the balance-sheet were stock on hand, which he had already dealt with; Prussian Consols, £5,120; English Consols, £29,004; and cash on deposit and in hand, £26,413. Referring to the report, the chairman stated that the litigation on the German patents had happily terminated. While the company suffered under the disadvantage of not knowing where they were, they could not push their trade, as the German law was rather terrible on the subject of damages for selling what might prove to be an infringement. The result, however, had shown that there had been no infringement; they were left to act without the fear of damages, and could now push the trade. In Germany they had a factory, and, with German forethought, intelligence and discipline, they should be able to turn out lamps scientifically perfect, and at a less cost than either in France or this country. The company had a large part of its capital invested in the Edison and Swan Company and in the French Company, besides the German residuum, and it might end in the lamps being manufactured in Germany for the several interests. The board, therefore, stated in the report that they "believe the time has arrived when a fusion of the residuum of the foreign business of the Swan Company with the British Edison and Swan Company may be effected with advantage to both interests, and negotiations are pending with a view to effecting some arrangements in this direction." This ought to be done as an economic and defensive measure, which would make both companies richer and stronger. Some arrangement might be come to by which the Swan Company should be merged into the Edison and Swan. The parties had agreed to the principle, appreciating the advantage which would accrue to both companies, though they had not arrived at the precise figures. The theory was that the Edison and Swan Company should purchase this residuum of the Swan Company at a price, with a commodity to be called debenture stock, bearing some reasonable rate of interest. He mentioned this so that the proprietors might realise the fact that something was pending which the board believed would be greatly in the interests of the company. Whenever the matter took shape special meetings of both companies would be convened, and it would be for the shareholders to accept or reject the proposition. The company had sustained a great loss by the death of Mr. F. R. Leyland, the deputy-chairman, and the directors had elected Major Flood Page, who had been secretary and manager for several years, to a seat at the board. Should the company be amalgamated, there would be no necessity for the present board, and the expenses would be reduced by about £2,500 a year. The Chairman concluded by moving the adoption of the report and accounts.

Mr. W. CUTHBERT QUILTER, M.P. (deputy-chairman), seconded the motion.

Mr. SKIPWORTH did not look on the balance-sheet as quite satisfactory, for, after taking into account the amounts received from the other companies, the Swan Company appeared to have been carrying on the factory at a loss. He was glad to learn that some progress had been made towards fusing the two companies.

The CHAIRMAN thought he had answered this point in anticipation. He had said that the expenses of production and machinery were far out of proportion to the work done—if the work was confined to the manufacturing of the lamps. Up to recently the chief work of the board had been to defend the legal position of the company and to save its capital in a series of very difficult litigations.

The motion was then put to the meeting and carried unanimously.

The CHAIRMAN next proposed: "That, in addition to the £14,558 9s. 8d. already distributed in respect of the six months ended March 31st, 1892, a further sum of £21,467 8s. 4d. be divided, free of income-tax, to be distributed in accordance with the provisions of clause 77 of the articles of association, making a total distribution for the year of £36,025 18s." The distribution of the amount (£21,467 8s. 4d.) in accordance with clause 77 of the articles of association will work out as follows:—On the 78,949 shares (£3 10s. paid), 4s. 2⅔d., per share; on the 19,750 shares (£5 fully paid), 4s. 11⅔d. per share; being, with the interim dividend previously paid, equivalent to 10 per cent. per annum on the shares £3 10s. paid, and of 8⅓ per cent. per annum upon the shares £5 fully paid.

Mr. QUILTER seconded the motion, which was agreed to.

The retiring directors—Messrs. J. S. Forbes and E. W. Batt, were next re-elected, as were the auditors, Messrs. Welton, Jones & Co.

A vote of thanks to the chairman and directors closed the proceedings.

The International Okonite Company, Limited.

THE following letter has been sent to the shareholders along with the report which we give below:

"Enclosed are the second annual report and the accounts for the year ending June 30th, 1892, of the International Okonite Company, Limited, of which you are a shareholder. This report and these accounts will be formally laid before the general meeting summoned for the 30th inst. Since these accounts have been audited your directors have been made aware of serious difficulties which have arisen in the administration of the Manchester factory, and which will necessitate their immediate and resolute interference. In addition to this, important engagements will prevent me from being able to be present at the meeting. It will, therefore, be proposed that the meeting formally held shall be at once adjourned until January 10th, 1893. At that date it is hoped the whole of your directors can be present to meet the shareholders, who will have had time to consider the accounts and report, and a complete re-organisation of the Manchester factory be accomplished and thoroughly explained to the shareholders.—Faithfully yours, SAMUEL POPE, *Chairman*."

The second annual report presented at the ordinary general meeting held on Wednesday last, November 30th, 1892, reads as follows:—"In forwarding the accounts for the year, the directors greatly regret that they show so unsatisfactory a result. Difficulties have arisen during the year both in America and in England, which have rendered the labours of your directors extremely anxious and onerous, and they have thought it their imperative duty to lay before their shareholders the accounts based upon such valuations as they think can be supported. The former valuations upon which dividends have been declared and paid were, as regards stocks in America, made by the American managers, but the course of business during the year satisfied your board that those valuations had been largely over sanguine, and they accordingly represented to the American managers (despatching the managing director, Mr. Vaughan-Stevens, to New York, to enforce their views), that some rectification of those valuations should be made in justice to the shareholders of the company. After a long and anxious negotiation, the board induced their American colleagues to surrender, for the general benefit of the concern, a sum of £20,000 in shares, which had been allotted to them as part payment of the purchase price. Had your directors felt justified in continuing to value the assets on the former basis, the profits of the year would, of course, have appeared to be much larger than they are; but they have felt that at any sacrifice, it was desirable that the accounts should start with a real, and not a sanguine valuation of assets. The small profit on the American business, therefore, largely arises from the reduction in assets by valuation on a sounder basis. In the balance sheet this matter has been dealt with, as you will see, by writing off £20,000 from the capital of the company. Although the American business, with this aid, shows a small profit, the loss which has arisen on the Manchester factory absolutely necessitates an immediate re-organisation of its administration, and as your directors have succeeded in obtaining valuable contracts in connection with the electric lighting of Manchester, Whitehaven, Melbourne, and other important places, they look forward with hope that such re-organisation may result in a more satisfactory account in the future. As the directors find that the accounts as audited show a total loss on the year's operation of £6,886 3s. 9d., they are unable to recommend the payment of any dividend. They think it right, however, to say that in making up the accounts full depreciation on all plant has been allowed for, and an amount set aside for contingent liabilities or bad debts, which, with this depreciation, more than accounts for the deficiency in question. The auditors, Messrs. Price, Waterhouse & Co., retire, and being eligible, offer themselves for re-election, which the directors recommend."

PROFIT AND LOSS ACCOUNT.

New York to May 31st, 1892, and England to June 30th, 1892.

Dr.	£	s.	d.
To London office expenses	1,352	7	0
„ Directors' and managing director's remuneration	2,500	0	0
„ Legal and professional charges	582	13	0
„ Audit fee	63	0	0
„ Trustees for debenture holders' remuneration ...	200	0	0
„ Travelling expenses	157	3	8
„ Interest on debentures	4,409	10	4
„ Depreciation of office furniture and fixtures, London office	86	12	3
„ Loss on exchange	53	4	1
„ Interest and Bank charges	939	6	8
	£10,343	17	0

Cr.	£	s.	d.
By profits of American business, after including the amount of share capital agreed to be surrendered by the managers and cancelled as compensation for excesive valuations of stocks, and after writing off depreciation, £5,689 17s. 11d.; *less* loss on Manchester business, after writing off depreciation, £2,242 9s. 8d.	3,447	8	3
„ Transfer fees	10	5	0
„ Balance, loss carried to balance sheet	6,886	3	9
	£10,343	17	0

BALANCE SHEET.

New York, May 31st, 1892, and England, June 30th, 1892.

LIABILITIES.

Dr.	£	s.	d.
To Capital—17,000 preference shares of £10 each, £170,000; *less* 1,000 preference shares agreed to be surrendered by managers and cancelled, £10,000, 5 preference shares forfeited, £50, £159,950; 17,000 ordinary shares of £10 each, £170,000, *less* 1,000 ordinary shares agreed to be surrendered by managers and cancelled, £10,000, £319,950; *deduct* calls in arrear, £1,015 ...	318,935	0	0
„ Amount received on shares forfeited	5	0	0
„ Debentures—1,000 bonds issued of £100 each, £100,000; *deduct* 150 bonds issued to bankers as security for loan, £15,000; *less* instalment unpaid, £1,805	83,195	0	0
„ Debenture interest due and accrued and outstanding dividend	1,927	19	5
„ Loans and mortgages—From bankers, £10,307 9s. 4d.; mortgages, £4,200	14,507	9	4
„ Sundry creditors	23,960	16	2
„ Bills payable	25,469	18	11
	£468,001	3	10

ASSETS.

Cr.	£	s.	d.
By purchase of properties and businesses in America and Manchester, as per balance sheet at June 30th, 1891, £218,979 14s. 1d.; *add* expenditure on new factories in America and Manchester, and purchase of lease (999 years) of mill at Newton Heath, Manchester, £7,334 2s. 6d.	226,313	16	7
„ Plant and machinery, tools, &c., as per balance sheet, June 30th, 1891, £79,023 16s. 1d.; additions since, £11,297 0s. 7d.; *less* depreciation, £5,472 15s. 9d.	84,848	0	11
„ Office furniture and fixtures, as per balance sheet, June 30th, 1891, £1,556 18s. 1d.; additions since, £207 4s. 8d.; *less* depreciation, £161 15s. 3d. ...	1,602	7	6
„ Stock-in-trade	111,872	19	2
„ Sundry debtors	28,261	13	5
„ Bills receivable	769	12	9
„ Cash at bankers and in hand	5,774	6	7
„ Preliminary expenses—As at June 30th, 1891, £1,960 1s. 3d.; *less* amount written off out of profits to June 30th, 1891, £287 18s. 1d. ...	1,672	3	2
„ Profit and loss—Loss as per annexed account ...	6,886	3	9
	£468,001	3	10

We have examined the foregoing balance-sheet with the books and vouchers in London, Manchester, and New York, and subject to the agreement for the surrender and cancellation of the 2,000 shares deducted from the share capital in the balance-sheet, being legally carried out, find it to be a full and fair balance-sheet, properly drawn up so as to exhibit a true and correct view of the state of the company's affairs as shown by the books of the company.

(Signed) PRICE, WATERHOUSE & Co.

London, *November 22nd*, 1892.

The annual meeting of the shareholders in the above company was held on Wednesday last at Cannon Street Hotel, Sir Alexander Armstrong, K.C.B., F.R.S., presiding, in the absence of Mr. Samuel Pope, Q.C., the chairman of the company.

The SECRETARY (J. C. Wylde), having read the notice convening

the meeting, also the letter from Mr. Pope, which had been circulated with the report,

The CHAIRMAN said: Gentlemen, the letter of the chairman would have prepared you for the motion which I am now about to make, and that is, that this meeting do stand adjourned until January 10th. You will then have had ample opportunity of fully considering the balance-sheet and going into all the details, and at that meeting the chairman will be in a position to afford you more information than I can possibly do. I therefore move that the meeting stand adjourned.

Mr. JOHN KENYON (shareholder) here arose and moved, as an amendment, "That the meeting be continued, and they proceed to investigate the affairs of the company." This was seconded by Mr. GLADSTONE (another shareholder).

The CHAIRMAN said he did not think they were in a position at present to go into any investigation; the motion was, that the meeting be adjourned. It would be very much in the shareholders' interests to accept the motion for adjournment, and have full discussion on January 10th. It could do no possible good now, but only be detrimental to their interests. He must therefore press the adjournment.

Mr. GLADSTONE said it was not a question of pressing the adjournment, it was a question of the amendment. Would the chairman kindly tell them who paid Messrs. Price, Waterhouse for the certificate which they gave with reference to the works in America?

The CHAIRMAN did not think it desirable to go into that question.

Mr. GRIFFITHS (shareholder) here said, that he had read with much attention the directors' report, and he had been looking at the articles or association, and, as originally drawn, the directors' remuneration in America was to be 5 per cent. on the profits. Of course, that apparently was not enforced; but the directors in England were to have received 3 per cent. on the profit and a certain sum. On looking at the balance sheet, he found that the sum claimed by the directors for remuneration for doing their work so badly, was far in excess of what the articles originally drawn allowed. He believed there had been some alterations in the articles, but, apart from that, he might say that on this present occasion, seeing that matters had turned out so differently from what the prospectus stated, for his own protection he there gave notice that he would consider himself entitled to give an action, and that by appearing at the meeting he did not waive that intention.

Mr. JOHN KENYON said this was an annual meeting and neither the chairman nor anybody else had a right to put it off beyond that time. Having come from Manchester to be at the meeting they could not but investigate the business, and it was a very unsatisfactory thing. They were in the wrong shop, and he recommended them politely to resign their positions as directors. If they did it honourably and at once it would save them a great deal of trouble, and then let other diectors be appointed, and the meetings be held at the works where they could see what was going on and understand something of the business and not come up to London to receive and pay and audit accounts. As shareholders, they should understand the position in which they were placed.

Mr. GLADSTONE said he was waiting for the chairman to answer his question.

Mr. MATHER asked a question in regard to the accounts.

The CHAIRMAN, replying to the question as to the payment of auditors, they were paid by the vendors.

SHAREHOLDERS: Shame!

The CHAIRMAN said, in regard to the criticism of the balance-sheet, that was no time to open it. The board had the power to adjourn the meeting as it was proposed to do; an amendment had been moved, and he would put it.

Mr. GLADSTONE, however, here moved another amendment, and that was that Messrs. Price, Waterhouse be dismissed from the office of auditors to the company, and they have an independent audit, and see what their property was now worth.

Mr. KENYON seconded this, and said he would prefer some Manchester accountants to do the auditing.

The CHAIRMAN stated that those were all questions which could be discussed on January 10th. They were not at present in a position to discuss a balance-sheet. It was the desire of the board to afford every possible information to the shareholders at the proper time.

A question was asked as to whether there would be any objection to the directors meeting some of the largest shareholders at the office.

The CHAIRMAN proceeded to say that this was a very good suggestion,

When Mr. GRIFFITHS said if they looked at the articles, it seemed mere child's play to say that they were to meet there merely because the directors were not in a position to do their duty, and to explain what was wrong. When the shareholders found that they had not that explanation, it was proposed that the explanation should be deferred, and this aroused suspicion, but when once suspicion was aroused they had better act upon that suspicion, and not allow themselves to be further treated in that way.

The CHAIRMAN said it was perfectly competent for them, having submitted the accounts, to adjourn the meeting for the reasons stated in the chairman's letter. He had no doubt that any shareholder calling at the office of the company would get information from the gentlemen there.

Mr. GLADSTONE said he had called at the office, and the information had been most unsatisfactory.

Mr. KENYON said this was the annual meeting, and they did not know that they might be alive on January 10th. They were in order in having a proper meeting.

The CHAIRMAN said they had called the meeting in order that they might have postponement.

Mr. JOHN HENRY TOD (a director of the company) said that they had been obliged to call the meeting now to postpone the matter. There were certain reasons why it was not expedient in the shareholders' interests, and in the interests of the company generally, that they should there go into those matters. They hoped by January 10th that things would have settled down in such a way as to enable them to give the shareholders a full explanation. Anything that had been moved to-day might be moved then, and he was perfectly certain that any shareholder who came to the office would get information given him, but it was not expedient that the whole thing be brought out at the moment. In postponing the meeting they might cause a little inconvenience to some of the shareholders; but he would also remind them that many shareholders who likewise had the feeling that the state of things was unsatisfactory, had not come to the meeting simply because they knew that it would be adjourned until January 10th. They had a very large number of proxies to carry out that intention; on that date they might say what they liked about the direction or anything else.

Mr. MATHER said that it was reasonable for the board to expect that shareholders who had come from a distance to attend the meeting should be anxious to obtain all the information they could. The question he asked was suggested by the report and accounts before them. It was briefly this, whether the £5,000 shown as profit in the profit and loss account, would have been £15,000 loss, if it had not been for the £20,000 surrendered by the vendors, and he submitted that that surrender being in shares, should have been merely a deduction from the assets, reduced the assets by that amount, and it does not affect the trading account of the company.

Mr. SHAW asked a question or two relative to the accounts which had been presented to the meeting. Mr. Mather had anticipated him by asking a question relative to the profits on the American business. He would now ask a question relative to the Manchester business. They had no statement in the profit and loss account saying how that supposed loss on the Manchester business had been made up. He had in his recollection a statement made by the auditor of the company, prior to his leaving Manchester two months ago, that there was not a loss, but a profit, after that depreciation was to be provided, and now they saw a loss of £2,242. He wanted to know what proportion had been written down so that loss could be shown. The reason he asked those questions would be shown on reference to the report.

The CHAIRMAN said he must call Mr. Shaw to order. It was wrong for a servant of the company to criticise the act of the directors. Mr. Shaw, on condition he resigned his position at once, had perfect freedom to speak.

Mr. SHAW said he would leave that question, then, for some other gentleman to ask. He would, however, ask what part had the directors taken in securing the three contracts mentioned on the page of the report.

A few further statements having been made by Mr. GLADSTONE and Col. HEMANS, amidst a deal of commotion,

The CHAIRMAN said that at the next meeting they hoped there would be a revival of confidence on the part of the shareholders. The discussion could answer no purpose. There was another point; the accounts for America would be made up to the end of the six months, December 31st, and submitted at the January meeting.

Some SHAREHOLDERS asked whether it was a fact that they were going on losing at that frightful rate during the next six months.

After some further discussion regarding the auditors and other matters,

The CHAIRMAN put the original motion, "That the meeting be adjourned."

There were, however, more shareholders present in favour of the meeting proceeding forthwith, than in favour of the adjournment; but the chairman laid on the table a number of proxies, and declared the meeting adjourned.

For some time a number of shareholders remained behind to talk over matters, and altogether the proceedings were of a noisy character.

Stock Exchange Announcements.—The Stock Exchange Committee have (1) appointed special settling days as under: Thursday, December 1st, City of London Electric Lighting Company, Limited—Six per cent. preference shares, Nos. 1 to 20,000. Friday, December 2nd, National Telephone Company, Limited—90,950 Third preference shares, Nos. 1 to 90,950. And (2) ordered the undermentioned securities to be quoted in the official list: City of London Electric Lighting Company, Limited—6 per cent. preference shares, Nos. 1 to 20,000. National Telephone Company, Limited—Additional ordinary shares, Nos. 447,235 to 454,747; 90,950 Third preference shares, Nos. 1 to 90,950. Reuter's Telegram Company, Limited—1,000 additional shares, Nos. 10,803 to 11,802.

Brazilian Submarine Telegraph Company, Limited.—The directors of this company, on Wednesday last, declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended September 30th last, and payable on December 21st. The transfer books of the company will be closed from December 13th to 20th, both days inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 27th, 1892, amounted to £893; corresponding month, 1891, £806; increase £87; total receipts to date, 1892, £17,900; corresponding period, 1891, £16,173; increase £1,727.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 25th, after deducting 1 per cent. of the gross receipts payable to the London Platinotype Telegraph Company, Limited, amounted to £3,979.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation November 24th.	Closing Quotation, December 1st.	Business done during week ending December 1st, 1892. Highest.	Lowest.
195,100*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 –103	100 –103	...	...
1,247,720*l*	Anglo-American Telegraph, Limited	Stock	50½– 51½	50 – 51	50¾	50
2,876,140*l*	Do. do. 6 p. c. Preferred	Stock	91 – 92	90½– 91½	92	90¾
2,876,140*l*	Do. do. Deferred	Stock	11¼– 11⅝	11 – 11⅜	11⅜	11⅛
130,000	Brazilian Submarine Telegraph, Limited	10	10¾– 11¼	10¾– 11¼	11⅛	10⅞
34,600*l*	Do. do. 5 p. c. Bonds	100	101 –104	101 –104	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	106 –110	106 –110	110	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3½– 3⅝	3 – 3¼	...	...
75,000	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅜– 2⅝	2⅛– 2⅜	2¼	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 – 4	3 – 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	3 – 4	3 – 4	3⅛	3⅛
40,000	City of London Elec. Lighting Co., Ltd., Ord. 40,001-80,000 ...	10	10½– 11	10¼– 10⅜	10⅜	10⅜
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000	10	... ...	5 – 5⅛	5 5/16	...
$7,716,000	Commercial Cable, Capital Stock	$100	183 –185	178 –182	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16– 5/16	3/16– 5/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5¼– 5⅜	5¼– 5⅜	5¼	...
16,000	Cuba Telegraph, Limited	10	11½– 12½	11½– 12½	12⅛	...
6,000	Do. do. 10 p. c. Preference	10	17½– 18½	17½– 18½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	2½– 3½	2½– 3½	...	...
6,000	Do. do. 10 p. c. Preference	5	9 – 10	9 – 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅛– 11⅜	11⅛– 11⅜	11¼	11⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14¾– 15	14¾– 15	15	14¾
70,000	Do. 6 p. c. Preference	10	15¾– 16¼	15¾– 16¼	16¼	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 –110	107 –110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	109 –112	109 –112	111	109¾
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞– 15	14⅞– 15⅛	15	14⅝
70,600*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	104 –107	104 –107	...	...
250,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	104 –107	104 –107	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	109 –112	109 –112	110	...
122,400*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	104 –107	104 –107	...	...
163,700*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	104 –107	104 –107	...	...
300,000*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 –106	103 –106	104	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	3½– 4	3½– 4	3¾	3⅝
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ..	... ...	...	...
100,000	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	3/8– 5/8	3/8– 5/8	...	...
82,395	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	1¼– 1½	1¼– 1½	1 7/16	1⅜
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	5/8– 7/8	¾– 1	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 – 3	2 – 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9¾– 10	9¾– 10	10	9⅝
180,042	Do. do. 6 p. c. Preference	10	14⅞– 15⅛	14⅞– 15⅛	15 1/16	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	19 – 19½	19 – 19½	19½	...
210,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	104 –107	104 –107	106½	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	4½– 5½	4½– 5½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	8 – 9	8 – 9	...	...
50,000	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21 – 22	21 – 22	21⅝	21⅛
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	102 –104	102 –104	...	...
17,000	Indo-European Telegraph, Limited	25	43 – 45	43 – 45	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½– 3½	2½– 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 – 7	6 – 7	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16– 3 9/16	3 7/16– 3 9/16	...	...
10,000	Do. do. fully paid	5	5 1/16– 5 3/16	5 1/16– 5 3/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 – 7	6 – 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	107 –110	107 –110	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6½– 7	6½– 7	7	6⅞
50,000*l*	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	103 –106	101 –104 xd	...	...
454,747	National Telephone, Limited, Nos. 1. to 438,984	5	4⅞– 5⅛	4⅞– 5⅛	5 1/16	4 15/16
15,000	Do. 6 p. c. Cum., 1st Preference	10	14 – 15	14 – 15	14⅛	14 9/16
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13⅞– 14¼	13⅞– 14¼	14⅛	13⅞
90,950	Do. 5 p. c. Non-cum. 3rd Pref., Nos. 1 to 90,950 ...	5	... ...	3¼– 3½	3⅜	...
726,477*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	112 –114	112 –114	113⅛	113
48,800*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	3⅞– 4⅛	4⅜– 4⅝	4 1/16	3 15/16
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	5 – 6	5 – 6	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16– 5/16	3/16– 5/16	...	...
11,802	Reuter's Limited	8	7½– 8½	7½– 8½	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8 – 8½	7¾– 8½	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 – 8½	8 – 8½	8 5/16	...
3,381	Submarine Cables Trust	Cert.	116 –120	116 –120	118	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3½– 3⅝	3 – 3¼xd	3½	3 3/16
37,350	Telegraph Construction and Maintenance, Limited	12	45 – 47	45 – 47	46½	45½
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 –106	103 –106	...	...
58,000	United River Plate Telephone, Limited	5	2½– 3	2½– 3	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 – 100	90 – 100	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½– 7½	6½– 7½	...	...
260,900*l*	Do. do. do. 5 p. c. Debentures	100	100 –103	100 –103	101½	100¼
30,000	West Coast of America Telegraph, Limited	10	2½– 3½	2½– 3½	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	103 –107	103 –107	...	...
64,242	Western and Brazilian Telegraph, Limited	15	7½– 8	7½– 7⅝	7½	...
33,129	Do. do. do. 5 p. c. Cum. Preferred	7½	5⅝– 6½xd	5½– 6	...	...
33,129	Do. do. do. 5 p. c. Deferred	7½	1⅜– 2¼	1½– 2	2	1⅜
184,100*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	106 –109	106 –109	...	...
230,100*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	106 –109	106 –109	...	...
88,321	West India and Panama Telegraph, Limited	10	1½– 1¾xd	1¼– 1½	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 – 10½xd	10 – 10½	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8½– 9½xd	8 – 9	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	104 –107	104 –107	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 –125	120 –125	...	...
171,000*l*	Do. do. 6 p. c. Sterling Bonds	100	100 –103	100 –103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5½– 6	5⅝– 6½	5 1/16	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

BANK RATE OF DISCOUNT.—3 per cent. (October 20th, 1892).

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7⅛—7⅜.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3⅛.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6⅞—7⅛.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20⅛.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2⅛—3⅛.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5—5½, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5⅛—5⅜.—Liverpool Electric Supply Shares of £5 (fully paid), 5 1/16—5 3/16.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid) 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 103—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (fully paid), 2⅛—3.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

AN ordinary general meeting of the Institution was held on Thursday, November 17th, 1892, Prof. W. E. Ayrton, F.R.S., President, in the chair.

The minutes of the ordinary general meeting held on November 10th having been read and approved, the adjourned discussion on Mr. Swinburne's paper on "THE PROBLEMS OF COMMERCIAL ELECTROLYSIS" was continued.

Mr. G. L. ADDENBROOKE having made a few remarks,

Mr. LLOYD said: Prof. Thompson introduced the subject of cobalt at the last meeting. The deposition of cobalt is a comparatively easy matter; cobalt, I believe, is easily deposited with a double sulphate of the salt, and ammonia also has been successfully obtained from a double chloride of the salt. The matter, which to me, however, seems of far greater importance, is the deposition of alloys with alloys; this is a distinct advance. I refer just at present to the deposition of silver alloys. When you come to consider the outpnt of Sheffield in a year, say, 1883, which was upwards of 300,000 ozs., and suppose that amount of silver be alloyed with, say, 20 per cent. of a metal which may be only 50 per cent. cheaper, the saving at the end of the year, when the matter comes to be calculated out, amounts to a larger figure than might be expected, something, I believe, like £5,000. This is not the only saving; there is also a large saving in the outlay of capital. The cost of bath and anode is much cheaper. Suppose now that an alloy can be obtained, say, at just 10 per cent. cheaper, and that alloy possesses more valuable properties than the original metal; it is harder; it is less expensive. I would call your attention in particular to some samples of silver alloyed with cadmium; the amount of cadmium is comparatively small. The properties of the metal are considerably improved, and I think that many will find that it is very difficult to find any difference in the colour between the alloy, hard standard silver, as named on the specification, and the samples of pure silver plating which I show. The deposition of alloys, however, is by no means a simple matter. In depositing simple metals, there is really comparatively little for the electrician to do beyond the mere measurement of the current and the potential difference at the terminals of the bath; but in the deposition of alloys there is a great variety of secondary matters coming in which require more or less attention, in order to understand how they vary the deposits we produce. Palladium plating will probably come into considerable use in future, if the properties of the metal respecting its non-oxidisability, and the high temperature that materials coated with it will stand without the metal peeling off, be considered. We have used it considerably for mirrors, and we have found it stand the heat of the arc almost better than any other metal.

Mr. E. J. BEVAN: The formation of chlorides was one of the chief objections of Dr. Hurter to the process, and if in practice the large amount was formed that he declared to be formed, of course the process could not possibly pay. On the other hand, we are told that the process is a profitable one. Another thing, there is the question of power. Mr. Swinburne takes it at a farthing per kilowatt, and several speakers were of opinion that this was an extravagantly low price. I cannot really see how, if you take a liberal allowance for coal, labour, and all the other charges incidental to that matter, you can get the price very much more.

Mr. A. P. TROTTER made some remarks with reference to electric tanning and dyeing, pointing out the extremely small power required in the first process.

Mr. ANDREOLI pointed out the importance of ozone processes, and referred to electro-chemical bleaching.

Mr. COOPER: At the present moment, on the continent, we are bleaching in bleaching mills paper pulp, cotton and yarn, equal to 3,000 tons of bleaching powder per annum.

Mr. BLOUNT made some remarks relative to the treatment of copper ores.

Mr. MORDEY read a communication from Mr. Swan relative to Mr. Swinburne's paper. Mr. Mordey described the action of carbon anodes.

The PRESIDENT: With reference to the gold amalgamation process, I made experiments and prepared tubes of similar mercury and put similar particles of gold on the top, and then sent a current for a certain number of hours through one tube, and no current at all through the other. In the morning or next day, or the day after, I analysed the layers of mercury in each of the two vertical tubes, and in the case of the one without current, the mercury at the bottom was pure, and in the one with current the mercury at the bottom contained a good deal of gold, showing that the mere passage of current conveyed gold down to the bottom of the mercury.

Mr. SWINBURNE then read a communication from Mr. Alex. Sinclair. The first point I find myself at variance with Mr. Swinburne is as to the cost per kilowatt-hour which he places so low as 0·25d. True, a works run on the line he indicates is naturally an inefficient one, still one farthing per kilowatt seems absurdly low, for, 1 kilowatt taken as 1·34 electrical H.P., and taking an efficiency from steam to external work to be 75 per cent., an efficiency seldom attained, the I.H.P. would be 1·8, and suppose coal to be 1·75 lbs. per I.H.P.—a very low figure—it would therefore be required, to produce 1 kilowatt-hour under the favourable circumstances which I have above indicated, 3·15 lbs. of coal, which taken at 10s. per ton, would give 0·168d. for coal alone; taking coal to represent one-half, a figure I have found fairly regular, the kilowatt will cost 0·336d. for simple production, without taking into consideration depreciation, interest on capital, rent, taxation, repairs and depreciation of buildings. Taking all these things into consideration, 0·5d. would seem to be the figure nearer correct; even this I believe to be low. The refining of copper by Mr. Hayken's process, which differs only from others by the vats being connected in series whilst they are connected in parallel, being taken as from 20s. to 25s. per ton, certainly does not seem tenable; under the most favourable circumstances 400 kilowatt-hours are required to deposit 1 ton of copper, which, taken at half per kilowatt, would be 16s. 8d. Again, the fact of having to roll the copper to $\frac{1}{4}$ to $\frac{3}{8}$ inch thick and then cast to shape, as many will readily see, will cost from 15s. to £1 per ton. These items in themselves come to more than the price given; probably some three to four times that figure would be the better value, and even on to that must be added the after treatment of the copper and bullion recovered.

Mr. SWINBURNE having replied the meeting adjourned.

EXPERIMENTAL RESEARCHES ON ALTERNATE CURRENT TRANSFORMERS. By J. A. FLEMING, M.A., D.Sc., F.R.S., Member. (Read November 24th.)

1. So much has been already written on the theory and performance of real and imaginary transformers, that some excuse might seem necessary for venturing to add to the literature of the subject; and yet, when we come to review that which is absolutely accepted as settled truth with regard to transformers, we find acknowledged authorities were no long time ago, and perhaps are now, in entire disagreement with each other on matters which seem vital and fundamental. At the time when the investigations described in the following paper were commenced, the matters in high dispute involved such practical questions as the relative superiority or advantages of open and closed magnetic circuits, the relative magnitude of the core losses at full and at no load, and the most trustworthy experimental methods of determining these transformer losses. During the many months that these experiments have been in progress, important contributions have been made to the solution of these questions in papers by Dr. Hopkinson, Prof. Ayrton, and Dr. Sumpner. Applying their own particular methods, they have reached conclusions on some of these points which it will be seen are similar to those arrived at in the following pages. As my own experiments, which were almost complete before these papers appeared, have been made with apparatus and instruments obtainable in most electrical workshops, and have not been limited to one or two special transformers, but have been made with stock sizes of many different kinds and types of transformers, it seemed likely that they might have sufficient independent value to justify me in bringing them before you.

These experiments had their origin partly in my own desire for definite and trustworthy facts as to actual transformers in use, and partly arose out of an invitation of Mr. Swinburne to examine his "Hedgehog" transformer, and compare its performance with that of some closed magnetic circuit transformer of equal size. They have, however, gone beyond that last-mentioned aim, and it forms no part of my purpose to draw comparisons between transformers from a commercial point of view, but simply to record facts of observation and leave them to speak for themselves. As a matter of fact, it is a very difficult thing to institute exact comparisons between commercial transformers as made by different makers. In the first place, they take different stock sizes, and they design their instruments for different frequencies. Hence, if we procure stock sizes for experiment, they are not directly comparable. In the second place, if special sizes of equal output are specially made, the maker cannot generally do himself justice unless he has *carte blanche* as to price, and from a commercial point of view price is everything; and, lastly, as such experiments cannot be done all in a minute, but generally take many months to complete, the experimentalist finds himself often, when all is said and done, met by the progressive manufacturer with the placid remark, "Yes, but the transformer you have been testing is our *old* pattern; you have not seen the one we are making now." One of the objects of this investigation was to arrive at some definite certainty on the best practical method of quickly testing transformers in actual use and *in situ*. The particular methods employed by Dr. Hopkinson and Profs. Ayrton and Sumpner involve the possession of two transformers of equal size. These methods are in principle an extension to transformers of Dr. Hopkinson's method of measuring the efficiency of dynamos, and they are based upon the obviously right method of measuring directly the quantity we desire to know—viz., the power lost in the transformer—rather than measuring it as the difference of two very much larger quantities—viz., the power going in, and the power coming out. These methods, as well as others which depend upon the graphic description of the current and electromotive force curves, have the disadvantage that it is often impossible to apply them, because only one transformer is at disposal, or because the observer has not access to the dynamo, and accordingly the first matter which engaged attention was an examination of the degree of accuracy to be reached by the simple direct methods which can be applied under such conditions as can generally be obtained in practice, and when using the commercial instruments to be found or obtained in every testing laboratory.

I.—METHODS OF MEASUREMENT EMPLOYED.

2. In order that an opinion may be formed as to the confidence to be placed in the quantitative experiments described, it may be well to give, in the first place, some details as to the methods adopted for measuring the potential differences, currents, &c., and processes of calibrating the instruments used. These instruments were, then, employed in measuring the power taken up by transformers with open, or loaded, secondary circuits. As single transformers only of each type were at disposal, we entered on a preliminary investigation on the degree of accuracy to be obtained when using such methods as the three-voltmeter, the three-ammeter, and the two-circuit electro-dynamometer wattmeter of various constructions.

In order to avoid tedious repetitions, it may be observed once for all that when mention is made of "the current," or "the potential difference" of such and such an amount, the *effective* value is meant.

or the square root of the mean of the squares of the equidistant instantaneous values, unless otherwise stated. The letters P.D. are used as an abbreviation for *effective* potential difference.

Mr. Swinburne placed at my disposal four of his electrostatic torsional voltmeters, and also two of his dynamometer wattmeters, and there were also at hand a sufficient supply of Kelvin current balances and electrostatic voltmeters and other appliances for the calibration of the above instruments. Since these Swinburne electrostatic voltmeters proved useful in much of the work, it may be advantageous to point out their good and bad points, and also to say how they were improved, calibrated, and used in these experiments. As they have been sufficiently described by their inventor, suffice it to say that they consist of two tiers of semi-cylindrical metal boxes, insulated from each other. A vertical metallic axis carries two semi-circular aluminium "needles," set at different levels, so that one is enclosed in the upper pair of boxes and the other in the lower. This needle is strung at the top and bottom by a round phosphor-bronze wire 0·003 or 0·004 inch diameter, and the top end of the upper wire is held by a torsion head, the indicating needle of which moves over a graduated scale. In most of the experiments these voltmeters were used as idiostatic voltmeters, and the "needle" and one pair of semi-cylinders formed one terminal of the instrument, and the other pair of semi-cylindrical boxes the other terminal. When a definite potential difference is made between the two terminals, the needle is displaced from its normal position, and the semi-circular needles attracted into the semi-cylindrical enclosing boxes, which are at a different polential. The upper torsion head is then turned until the needle comes back to its initial position. This is accurately determined by affixing a mirror to the axis of the electrometer needle. The image of the filament of an incandescent lamp is then thrown on the mirror by a lens, and, after reflection, received on a paper scale about 1 metre away. By a simple reference point on this scale it is easy to bring back the line of light accurately to its original position. In first working with these instruments we were greatly troubled by electrical discharges passing across from the "needle" to the cylinders and destroying the suspending wire by the resulting current. The simple remedy for this was found in enclosing each semi-circular aluminium disc of the "needle" between two thin sheets of mica, which projected slightly over the edge of the sheet of metal. The instrumental utility of the voltmeter was not at all impaired, whilst at the same time discharges between the needle and enclosing boxes were prevented, and much labour thereby saved. The sensitiveness of the voltmeter was such that when used to read an alternating potential of 2,400 volts, a difference of 3 or 4 volts was easily detected, and with sufficiently steady potential there was no difficulty in taking the reading of about this number of volts to one-quarter per cent. accuracy. The great defect of the instrument as it stands is the large moment of inertia of the needle, and this, in the absence of any effective damping arrangement, creates a great waste of time in getting readings.

The instruments were provided with an electro-magnet intended to be used for creating a magnetic damping field. This, however, proved to be ineffective. A far better plan when such a heavy needle is employed is to damp out the oscillations by a suitable mica vane dipping in oil or water.

3. In calibrating these voltmeters, the first step was to prepare a standard inductionless resistance capable of carrying, without sensible heating, a current of at least a quarter of an ampère, and which could be subjected to an alternating pressure of 2,000 to 3,000 volts without risk of short-circuiting. This was formed by winding double silk-covered platinoid wire (No. 36 B.W.G.) round a wooden frame. The wire windings were each kept separate by being wound in serrations, or teeth, cut in the edge of varnished slate slips fixed at the top and bottom of the frame. The frames were about 37 inches long and 14 inches wide, and the wire made 56 turns round the frame, each turn of wire being separated by about a quarter of an inch from its neighbours. The length of wire on each frame was about 126 yards, measuring some 1,600 ohms. Six of these frames were provided, giving us, therefore, about 9,600 ohms resistance in the form of a wire perfectly insulated in every part and between every turn. The wire was capable of carrying about one-quarter of an ampère without any very sensible heating, and about three-quarters of an ampère without exceeding safe limits. Every part of the wire was accessible, and exposed to the cooling action of the air. The six frames were fastened up to the ceiling of the laboratory, and arranged so that the direction of the wire windings was alternately right and left. The resistance of all these coils was measured when at 15° C. and found to be as follows:

Coil 1	... ...	1,607·2 ohms.
„ 2	... ...	1,505·5 „
„ 3	... ...	1,525·5 „
„ 4	... ...	1,649·0 „
„ 5	... ...	1,610·1 „
„ 6	... ...	1,645·7 „
	Total	9,543·0 „

On coil 1 two terminals were placed, one at a distance of 394·7 ohms from the end, and one at a distance of 1,212·5 ohms from the end. By taking leading wires from these points it was possible to divide the whole resistance of 9,543 ohms into two sections, having in one case resistances in the ratio of 23·175 to 1, and in the other case a ratio of 6·87 to 1. This divided resistance was a practically non-inductive resistance of about 10,000 ohms, divisible into two sections in the ratio of 23 to 1 or 7 to 1. If a measured alternating pressure of 2,400 volts was applied to the ends of this resistance, the wire came to a steady temperature of about 20° C. to 25° C. above the atmospheric temperature (15° C.), as nearly as could be judged by a thermometer. Taking the coefficient of change of resistance with temperature for platinoid as equal to 0·021 per cent. per degree, it will be found that at 40° C. the whole coil would have a resistance of 9,591 ohms, and hence, if truly non-inductive, the current through the coil would then have a value of $\frac{2400}{9591}$ ampère, = 0·250 ampère. The actual current, carefully measured by a Kelvin deciampère balance, was found to be exactly 0·250 ampère, thus showing that the resistance was, for all practical purposes, non-inductive.

In all subsequent experiments it was, therefore, taken that when an alternating pressure of 2,400 volts was applied to this resistance, it passed a current of 0·25 ampère and absorbed 600 watts. This resistance will be hereafter called the "No. 1" resistance, for reference. By the aid of this divided resistance the Swinburne voltmeters were easily calibrated.

A 24 to 1 transformer, T (see fig. 1), was connected to 100-volt

PLAN OF CONNECTIONS USED IN CALIBRATING SWINBURNE VOLTMETERS

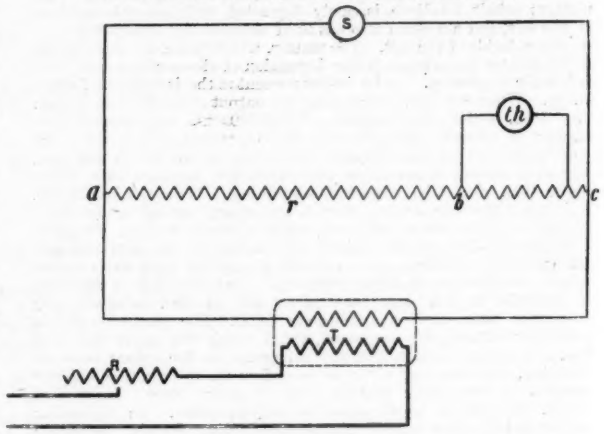


FIG. 1.

mains through a rheostat, R, so as to raise the pressure and enable it to be regulated within limits. The above standard divided resistance was placed across the high-tension terminals, and a Kelvin multicellular electrostatic voltmeter, Th, and a Swinburne electrostatic voltmeter, S, connected respectively to the small section and to the whole length of the resistance shown in fig. 2.

By taking the readings of the Kelvin electrostatic voltmeter corresponding to various pressures and multiplying these readings by 24·175 we obtained values for the P.D. at the terminals of the Swinburne voltmeter, and hence the true values of the instrumental readings of the last named instrument. For each Swinburne voltmeter a calibration curve was then prepared in which the horizontal abscissæ were the torsion-head readings, and the corresponding ordinates the true P.D. in volts at the terminals of the instrument. This curve was found to be a very exact parabola. Having proved this to be the case by many experiments for each of the four Swinburne voltmeters, we subsequently adopted for each voltmeter an instrumental constant, the product of which by the square root of the torsion-head reading gave the terminal P.D. on the instrument. These constants were determined for each instrument at the beginning and end of every set of experiments.

In addition to the above standard resistance, another set of six similar coils was provided, each coil of which consisted of No. 32 B.W.G. platinoid wire, wound in the same open manner on a frame. Each of these coils had a resistance of about 500 ohms, and each coil could carry comfortably, without any very sensible heating about half an ampère. These last six coils were specially intended to be used for current measurement, as follows:—The coils were arranged either two, four, or all six in parallel, and the current to be measured passed through them. The P.D. at the ends of the compound resistance was measured by a Kelvin electrostatic voltmeter. The arrangement was standardised as an ampèremeter by passing known currents through the coils, measured by a Kelvin ampère balance, and then observing the P.D. at the ends of the compound resistance. In this way the true resistance of the coils grouped in various ways when carrying currents was found, and at any subsequent time the mere reading of the P.D. at the ends of the resistance gave the current passing through the coils. The reason for employing an electrostatic voltmeter and resistance in this way to measure current was that we thereby obtained an inspectional ampèremeter much more convenient in many experiments than an ampère balance or dynamometer. It will be seen, therefore, that all the measurements were ultimately referred to one Kelvin electrostatic voltmeter and one Kelvin deci-ampère balance. These instruments were found to agree with one another. Any other instruments, such as Siemens's dynamometers or an Ayrton and Perry twisted strip ammeter, sometimes used, were standardised and referred to the above-mentioned Kelvin balance, which was one specially constructed for alternating current measurement.

This last-mentioned set of six resistance coils will be hereafter spoken of as the "No. 2" set. We frequently employed the No. 1 and No. 2 resistances in series, giving us a practically non-inductive resistance of about 12,000 ohms. The No. 1 resistance was also employed as an absorber of power. For if the six coils, each of about 1,600 ohms, were arranged three in parallel and two in series, we obtained an effective resistance of about 1,100 ohms, and this, when placed across a 2,400-volt circuit, passed a total current of rather more than 2 ampères, and absorbed about 5,000 watts. We found it very convenient to employ this resistance in this manner as

a standard non-inductive power-absorber for obtaining the constant of various forms of wattmeter. Although using the No. 1 resistance in this way to absorb nearly 7 horse-power, the current passing in each single wire was not more than two-thirds of an ampère, or well within the safe limits.

II.—EXPERIMENTS WITH THE THREE-VOLTMETER METHOD OF MEASURING ALTERNATING CURRENT POWER.

5. Having the necessary instruments all calibrated and compared, a series of experiments was made with three or four of the Swinburne voltmeters, using them in accordance with the well-known method, for measuring the power taken up in transformers on open secondary circuit.

Two 5 H.P. transformers were arranged with low-tension coils in parallel on a 100-volt circuit, and high-tension coils (2,400 volts) in series (see fig. 2). The current through the low-pressure coils could be varied by a rheostat, *f*, and hence the P.D. at the high-tension terminals of the transformers given any desired value from 2,400 volts downwards.

In the diagram (fig. 2) T is a transformer in which the power taken

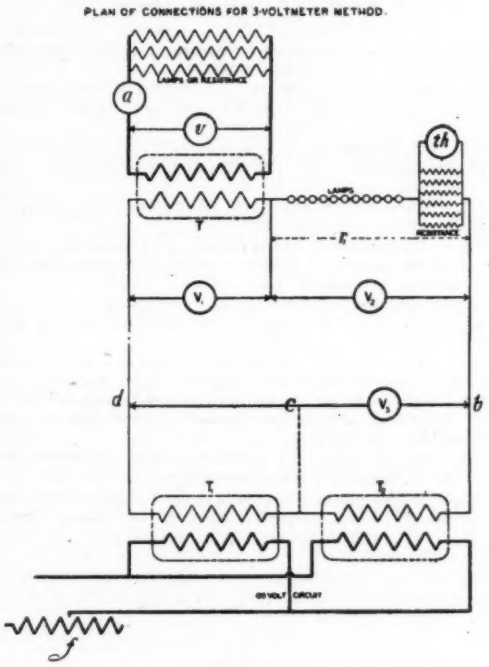


FIG. 2.

up is to be measured; T_1 and T_2 are the 5-H.P. pressure transformers just mentioned. The torsion voltmeters, v_1, v_2, v_3, were arranged as shown; v_1 being across the terminals of the transformer to be measured, v_2 being across a non-inductive resistance, r_1, put in series with the primary coil of the transformer T, and v_3 used to measure the total P.D. between the outside terminals of the two pressure-producing transformers, T_1 and T_2. Since T_1 and T_2 were identical transformers, it was generally quite sufficient to measure the P.D. between the terminals of one transformer, T_1 or T_2, and to take double this P.D. as the value of v_3, except in cases where the total P.D. exceeded the limits of safety for one voltmeter, and then two voltmeters were used, one across the terminals of each transformer. Under these circumstances, as is well known, the power, w, taken up in the transformer, T, under test is given by the formula,

$$w = \frac{1}{2 r_1}\left\{v_3^2 - v_2^2 - v_1^2\right\}$$

In applying this method we had several difficulties to overcome before we could get any satisfactory results. In the first place, the transformer to be tested must have the potential difference, v_1, between its primary terminals always exactly maintained at the normal pressure, which, in all our experiments, was 2,400 volts. In the second place, the potential difference, v_2, must always be made as nearly equal to v_1 as possible, in order to obtain the condition of greatest probable accuracy of measurement—that is, to obtain the condition in which given small percentages of error in the several voltmeter readings produce the minimum percentage error in the calculated power. In the third place, the resistance, r_1, must be practically non-inductive, and must be capable of being varied in amount as required to fulfil the condition of making v_2 equal to v_1. We met these conditions in the following manner:—In cases in which the transformer, T, was not loaded on the secondary circuit, and in which, therefore, the current flowing through its primary circuit was not greater than could be comfortably carried by the No. 1 10,000-ohm standard resistance, we employed that resistance, arranging all six coils in series. In series with this we placed some or all of the coils of the second resistance, arranged in series or in parallel, and we placed a Kelvin voltmeter to read the fall in volts down one of these last coils. In other cases, when the transformer, T, was loaded up on its secondary circuit, and when, therefore, a larger current was flowing through its primary circuit, we employed a series of 24 50-C.P. 100-volt incandescence lamps, or several series of lamps in parallel, adjusted as required to obtain the requisite resistance. When these lamp resistances were used, the second (No. 2) set of resistance coils, arranged with 2, 4, or 6 in parallel, as necessary, were placed in series with the lamps. By measuring the fall in volts down this known wire resistance by a Kelvin electrostatic voltmeter, *th*, and the fall in volts over the lamps and resistance taken together by means of one of the Swinburne voltmeters, v_3, we were able to determine at any instant the value in ohms of this non-inductive resistance from the readings of two electrostatic voltmeters and the known value of the wire resistance across the terminals of the Kelvin voltmeter.

The process of getting a reading was this: The resistance, r_1, was varied suitably until the value of the P.D., v_1, was as nearly as possible equal to the value of the P.D., v_2. The feeding transformers, T_1 and T_2, had a rheostat in their common low pressure circuit, which was then varied until the P.D., v_1, came to the value 2,400 volts, and it was constantly maintained at that value. The reading of the other two voltmeters was then noted, as well as that of the Kelvin voltmeter Th. If we call A the ampère value of the current flowing through the primary coil of the transformer, T, and therefore also that through the resistance *r*, it is obvious that the value of *r* is determined at once from the value of the P.D., v_3, and the value of the current A. A is, of course, known by the previous calibration of the Kelvin voltmeter and associated resistance as a non-inductive ampèremeter. Hence, if v_1 is constantly maintained at the value 2,400 volts, we see that the power, w, taken up in the transformer is given by the formula,

$$w = \frac{A}{2 v_2}\left\{v_3^2 - (2{,}400)^2 - v_2^2\right\}.$$

If it had been possible to make v_2 also always exactly 2,400 volts, the formula would have been still more simplified.

(To be continued.)

APPLICATIONS TO BE MADE TO PARLIAMENT AND BOARD OF TRADE FOR VARIOUS POWERS.

THE following announcements have appeared in the *London Gazette*:—

Application to Board of Trade, 1893 session, by the Beckenham (Kent) Urban Sanitary Authority for a provisional order empowering them to produce, store, and supply electricity within the urban district of Beckenham, Kent, to acquire and appropriate land and to construct works, to break up or interfere with streets, railways, tramways, and canals, and to lay down or erect mains, pipes, wires, and apparatus, to demand and levy rates and charges, enter into houses and buildings, contracts, and transfer of undertaking, borrowing of money, and other powers.

Application to Board of Trade, 1893 session, by the corporation of Kingston-upon-Hull, for provisional order authorising the construction of certain tramways in Hull. Power to be reserved in the order for working the trams by animal, steam, cable, electrical, or other motive power.

Application to be made to Board of Trade, 1893 Session, by the Birmingham and Midland Tramways, Limited, for a provisional order authorising the company to lease their undertaking to any company, local authority or corporation, also empowering the said company to work the tramways by cable, electrical, compressed air or other motive power. The usual incidental powers are also to be applied for.

Application to Board of Trade, 1893 session, by the Bridgend Local Board for powers to produce, store, and supply electricity within the district of the Local Board; to acquire and appropriate lands, and to construct works, to break up or interfere with streets, railways, tramways, canals, and rivers, and to lay down or erect mains, pipes, and wires; and other powers.

Application in Parliament, 1893 session, by the Brighton and Hove Electric Light Company, Limited, for power to produce and supply electricity for public and private purposes, within the municipal and County Borough of Brighton (including the parish of Preston), power to break up streets, and other places, lay down and interfere with pipes, wires, sewers, and other works, to acquire and hold lands, patent rights, &c., power of entry upon houses and buildings, inspection, testing, &c., of lines, meters, and other apparatus, transfer of undertaking to the local authority, and other incidental powers.

Application in Parliament, 1893 session, to authorise the construction of an electric (or mechanical power) railway between Brighton and Rottingdean (Sussex) with a jetty or landing stage at Rottingdean. Incidental powers also.

Application to Board of Trade, 1893 session, by the British Electric Light Company, Limited, for power to supply electricity in Newmarket sanitary district, breaking up of streets, &c., purchase, &c., of lands, rates, &c., agreements with local authorities, transfer of undertaking, incorporation of Acts, &c.

Application in Parliament, 1893 session, by the City and South London Railway Company, for extension of time for purchase of lands for and completion of subway or underground railway authorised by the City and South London Railway Act, 1890; power to acquire easements, amendment of Acts.

Application to Board of Trade, 1893 session, by the Colchester Corporation, for a provisional order authorising them to produce and supply electricity for public and private purposes within the Borough of Colchester, and to levy, make and recover rates and charges there-

for, and to break up streets and railways, and to cross rivers and canals, and lay electric lines, to manufacture, hire, sell, and let electric apparatus, and other incidental powers.

Application to Board of Trade, 1893 session, by the Birmingham Central Tramways Company, Limited, for a provisional order authorising the construction of tramways. Powers to be reserved in the order for working by animal, steam, cable, electrical, or other motive power.

Application to Board of Trade, 1893 session, for a provisional order to authorise the vestry of the parish of Hammersmith to supply electricity for public and private purposes in the parish of Hammersmith, in the administrative County of London, powers to construct works, to make, levy, and recover rates and charges, to acquire lands, to make arrangements with local authorities, to open streets and lay electric lines, to manufacture, hire, sell, and let electric apparatus, transfer of powers and other purposes.

Application to be made to Parliament, 1893 session, by the Harrogate Corporation for powers authorising the corporation to erect dynamos, engines, and other machinery for the generation and supply of electricity on the lands described and known as the Jenny Plain Farm or Irrigation Farm, and to authorise the corporation to erect or lay down conductors, electric lines, and other electrical apparatus, for the conveyance or transmission of electricity from the proposed works to the borough, and for those purposes to break up and interfere with streets, highways, drains, gas and water mains and pipes, and in respect of the matters aforesaid, to confer on the corporation all or some of the powers given to the corporation by the Harrogate Electric Lighting Order, 1891, and the Electric Lighting Acts, 1882 and 1888. Also powers to authorise telegraphic and telephonic communications within and beyond the borough between the municipal offices and residences of officers of the corporation, and between the various fire brigade stations, works, and police stations, and to incorporate all or some of the provisions of the Telegraph Acts, 1863 to 1889, in relation to the matters aforesaid.

Application to Board of Trade, 1893 session, by the Holloway Electricity Supply Company, Limited, for a provisional order to authorise the said company to supply electricity for public and private purposes, and to supply electrical power and energy in a part of the parish of Saint Mary, Islington, in the County of London; power to make charges, to acquire lands, to break up streets therein, to construct works, to lay mains, wires, and other apparatus, to make arrangements with local authorities.

Application in Parliament, 1893 session, by the Kensington and Knightsbridge Electric Lighting Company, Limited, for confirmation of agreement between the Kensington and Knightsbridge Electric Lighting Company, Limited, and the Chelsea Electricity Supply Company, Limited, transfer to the first-mentioned company of all or some of the powers conferred on the Chelsea Electricity Supply Company, Limited, by the South Kensington Electric Lighting Order, 1889, in respect of the whole or a portion of the area of supply under the said order, and the whole or a portion of the undertaking thereby authorised, power to constitute the undertaking so acquired a separate undertaking, and to raise capital for the purposes thereof, amendment of orders and Act; other powers and purposes.

Application to Board of Trade, 1893 session, by the County of London Electric Lighting Company, Limited, for power to produce, store, and supply electricity, electrical energy, and power within the county of London; to construct works; to lay down wires and other apparatus; to break up streets therein; to acquire land; to levy rates, and exercise other powers; agreements with and powers to local authorities; incorporation of acts, &c.

Application to Board of Trade, 1893 session, by the Manchester Edison-Swan Company, Limited, for a provisional order to supply electricity for public and private purposes, and to supply electrical power and energy in the Local Board districts of Altrincham and Bowdon and in parts of the district of the rural sanitary authority for the Altrincham Union in the County of Chester, to construct works, to lay mains, wires, and other apparatus; also other powers.

Application to be made to the Board of Trade, 1893 session, by the Reading Electric Supply Company, Limited, for a provisional order authorising the company to supply electrical energy for all public and private purposes within the County Borough of Reading, to execute works, to lay down electric lines, to break up streets, railways, and tramways, to cross canals and rivers, to make charges for energy supplied, and to enter into agreements relating thereto, to sell and let meters, to transfer the undertaking to the local authority, and other purposes.

Application in Parliament, 1893 session, by the Corporation of Salford, for powers to construct tramways to be worked by steam, animal, electrical, or mechanical power; also other various powers.

Application to Board of Trade, 1893 session, by the South Staffordshire Tramways Company, Limited, for powers authorising the construction of tramways in the borough and parish of West Bromwich and parish of Handsworth, use of cable, steam, electrical, mechanical, or other power, and other powers in relation to tramways.

Application to Board of Trade, 1893 session, by the Taunton Corporation, for powers authorising the production, storage, and supply of electricity by the Corporation of Taunton, within the Borough of Taunton, and within such portion of the district of the Taunton rural sanitary authority as lies within a radius of one mile and a half from the Taunton Market Cross, all in the county of Somerset; the acquisition and appropriation of lands and construction of works, the breaking up and interference with streets, railways, canals and navigable rivers, the laying down and erection of electric lines, pipes, wires and apparatus; also other incidental powers.

Application in Parliament, 1893 session, by the West Metropolitan Tramways Company, for powers to construct and work tramways by steam or other mechanical power, or by cable or electric power, revival of powers and extension of time, abandonment, purchase of land by compulsion or agreement, provisions as to capital, and other incidental powers.

Application in Parliament, 1893 session, by the Wigan Corporation for the making, formation and maintenance of new tramways in the borough of Wigan. The power to be used to be animal, steam, mechanical, or electric.

Application in Parliament, 1893 session, by the York Corporation, for powers to authorise the establishment of telegraphic and telephonic communications between the fire stations of the city and the fire stations of the districts of adjoining and neighbouring urban and rural sanitary authorities, and to mills, factories and buildings therein, and to authorise payments and charges in respect of the protection so afforded; and to empower the corporation to erect posts and wires for the purpose of such telegraphic or telephonic communication, and for those purposes to break up streets, roads and highways; and to confer upon the corporation all or some of the powers contained in the Telegraph Acts, 1863 to 1889.

NEW PATENTS—1892.

20,538. "Improvements in electrical cash or small parcel carriers." J. B. NICHOLSON. Dated November 14th.

20,590. "Means and electrical apparatus for preventing and killing blight on vegetation." R. H. COURTENAY. Dated November 14th.

20,598. "Improvements in and relating to the manufacture of electric accumulators." C. THERYC and A. OBLASSER. Dated November 14th.

20,602. "Improved construction of electric bell push." C. BRITCHER. Dated November 14th.

20,603. "Improvements in the fastenings of windows, doors, and other similar devices, and in electrical switches connected therewith." D. L. SALOMONS. Dated November 14th.

20,606. "Improvements in electric arc lamps." C. A. DAY. (Communicated by the Higham Electric Company, United States.) Dated November 15th. (*Complete.*)

20,610. "Improvements in telephone circuits." G. L. ANDERS and W. KOTTGEN. Dated November 15th.

20,611. "Improvements in governing electric motors." B. J. B. MILLS. (Communicated by R. Lundell, United States.) Dated November 15th. (*Complete.*)

20,621. "Improvements in electric burglar alarms." H. T. WILSON and N. SCHWAB. Dated November 15th. (*Complete.*)

20,637. "Improvements in insulators and other similar articles made of glass." D. RYLANDS and B. STONER. Dated November 15th.

20,641. "The carriage electric light apparatus." G. MURRAY. Dated November 15th.

20,646. "A method of making velocipede lamps, and other articles requiring soldering, of aluminium." J. LUCAS, H. LUCAS, and J. PERRY. Dated November 15th.

20,666. "An improved electro-magnetic alarm or call." P. RABBIDGE. Dated November 15th.

20,670. "Improvements in the arrangement of telephone circuits and switching devices therefor." Sir C. S. FORBES, Bart. Dated November 15th.

20,693. "Improvements in electric arc lamps." F. HANSEN. Dated November 15th. (*Complete.*)

20,698. "An improved electric arc lamp." H. H. BOYLE. Dated November 15th.

20,700. "Improved means for lighting trains by electricity." D. JONES. Dated November 15th.

20,729. "Improvements in dynamo-electric machines." J. A. KINGDON and WOODHOUSE AND RAWSON UNITED, LIMITED. Dated November 16th.

20,789. "A method of and apparatus for transmitting vocal and other sounds electrically." J. G. LORRAIN. (Communicated by C. Clamond, France.) Dated November 16th.

20,792. "An improved watchman's electric time recorder." W. W. HORN. (Communicated by E. R. Heyser, United States.) Dated November 16th.

20,864. "Improvements in telephone transmitters." R. POLLITZ. Dated November 17th. (*Complete.*)

20,894. "Improvements in and relating to telegraphic or telephonic call systems." H. WETZER. Dated November 17th. (*Complete.*)

20,900. "An improved process of manufacturing and depositing spongy lead for secondary or storage batteries or receivers." E. BAILEY and J. DUNHAM-MASSEY. Dated November 17th.

20,901. "Improvements relating to the electric lighting of railway carriages and other vehicles." E. BAILEY and J. DUNHAM-MASSEY. Dated November 17th.

20,912. "Improvements in or connected with telephone apparatus." R. J. URQUHART. Dated November 18th.

20,959. "An improved electric arc lamp." F. W. SUTER and S. J. SUTER. Dated November 18th.

20,964. "Improvements in electrical relays and apparatus for telegraphing to lighthouses either floating or on rocks at a distance from the shore or for telegraphing to and from vessels." W. S. SMITH and W. P. GRANVILLE. Dated November 18th.

20,989. "The detachable electric light bracket." A. W. UPCRAFT. Dated November 18th. (*Complete.*)

21,020. "An electric-governed night latch." E. WARD. Dated November 19th.

21,041. "Improvements in and connected with electromotors and in their application to electric tramcars and locomotives." J. A. KINGDON. Dated November 19th.

21,074. "Improvements in galvanic batteries." F. C. JAMES. Dated November 19th.

21,083. "Means for measuring or comparing sounds produced with telephones by the transmission of electric currents over a circuit." J. E. KINGSBURY. (Communicated by the Western Electric Company, United States.) Dated November 19th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

4,794. "Improvements in signalling and telephonic systems." J. E. KINGSBURY. (Communicated from abroad by the Western Electric Company, of Chicago. Dated March 17th. Comprises the employment of ringer magnets having a high coefficient of self-induction; the discontinuance of the ordinary practice of including the call sending generator and the ringer magnets serially in the same circuit when calling; the connection of the said appliance in different and parallel bridge cross wire or derived circuits of the main line; the ringer magnet bridge being normally and permanently closed or continuous at all stations, and the generator bridge circuit being normally open or discontinuous, but adapted to be closed while sending a call; and the connection of the telephones in a third bridge circuit at each station, this circuit also being open when the telephone is not actually in use, but closed in multiple arc with its own ringer magnet, and, of course, with the ringer magnets of other stations, when in use. 3 claims.

5,338. "Improvements in the form of carbons used in certain electric arc lamps." T. P. C. CRAMPTON and A. ESSINGER. Dated March 25th. Relates chiefly to the bottom carbon of electric arc lamps where this carbon is fed up from below by means of a weight or otherwise, so as to cause the carbon to constantly press against points formed of what is known as platina-irridium or some other highly refractory material. The inventors so form the carbon as to prevent any chance of slipping, such as may sometimes occur when plain smooth carbon rods are used. For this purpose they form the carbon with a series of horizontal ridges and grooves alternately. 2 claims.

5,989. "An improved means of wiring brackets, pendants, electroliers, and the like for electric lighting." E. W. LANCASTER. Dated April 7th. The inventor casts or solders inside the cup-shaped back-plate, ceiling-plate or body of the fitting, two metallic projecting pieces or lugs to which he screws an insulating piece of porcelain or other suitable material. To one side of this insulating piece he attaches a terminal piece, and to the other side a similar terminal piece. Each terminal contains two or more cable holes and binding screws, and to one terminal he connects the positive wires from the lamp or lamps and circuit respectively, and to the other terminal the corresponding negative wires.

6,633. "Improvements in or relating to electric meters." F. TEAGUE. Dated April 17th. In one part of the invention the integrating devices are, in some cases, mechanically disconnected from the parts actuated by the current, but are worked by magnetic induction through a cover or case; preferably air-tight, and exhausted of air; the case being adapted to contain the current actuating or actuated devices. In this manner the inventor is enabled to avoid oxidation of the mercury, keep all the contacts clean, and render unnecessary the re-calibration of instruments frequently required after they have left the manufactory. 7 claims.

6,793. "The application of electricity for the production of pyrotechnic and other effects, applicable also for signalling and advertising purposes, and apparatus therefor." P. C. E. CHAMPION. Dated April 20th. Relates to lines or groups of incandescent lamps, voltaic sparks produced by the breaking of the current at the desired point and instant, lines of small arcs, and the like, the combination of these three forms of electric light, and the appearance of motion imparted to them, either separately or in groups, by means of special mechanism, enabling all the luminous effects heretofore obtained by ordinary pyrotechnic compositions, to be realised. 8 claims.

7,331. "Improvements in and relating to telephonic apparatus of the Ader system." C. D. ABEL. (Communicated from abroad by Société Générale des Téléphones [Reseaux Téléphoniques et Constructions Electriques], of Paris). Dated April 28th. Claims:—1. In telephonic transmitters, the combination with the vibrating tympan of two pieces of carbon, presenting between them a V-shaped opening, in which rests one or more carbon or other conducting contact pieces, substantially as described. 2. In telephonic apparatus, producing a neutralising current for the local receiving instrument by locally transmitting to the bobbins of the local receiver a current the reverse of that passing through the same from the line, whereby the action of such current is neutralised when speaking into the local transmitter, substantially as and for the purposes described. 3. Producing the neutralising current referred to in the preceding claim, by means of a second separate induced coil in the induction bobbin, placed by the side of the ordinary coil from which the line current issues, such second coil being connected to a second reversing coil on the bobbins of the local receiving instrument, substantially as described. 4. Producing the neutralising current referred to in the second claim, by means of an additional induction bobbin, into the primary coil of which is passed the primary current of the transmitter, while the current of the second coil is connected to a second coil in the receiver bobbins, substantially as described. 5. Producing the neutralising current referred to in the second claim by means of a shunt circuit on the transmitter circuit, which is either connected to a second coil on the receiver bobbins, or is connected to the terminals of the ordinary coil, substatially as described.

7,850. "Improvements in automatic telephone exchanges." W. W. HORN. (A communication from A. B. Strowger, of America.) Dated May 6th. The object is to provide means whereby a person at one station may make connection with any other station in the system by means of electrical appliances without the aid of an operator at the central station. 5 claims.

7,858. "Improvements in switches used for electrical purposes." C. SCOTT SNELL and WOODHOUSE & RAWSON UNITED, LTD. Dated May 7th. The inventors make use of a lever or catch, attached to and rotating with, the contact-making brush, or its accessories, in such manner that at certain pre-arranged position this catch interlocks with a fixed block or the like on the switch base. 1 claim.

7,878. "Improvements in appliances for preventing ignition of gases in connection with dynamos, motors, or other electrical apparatus." F. J. ROWAN and W. MCWHIRTER. Dated May 7th. The inventors enclose the dynamo or motor in a casing provided with one or more glazed windows for inspection of the enclosed parts. Stuffing boxes or very closely fitting apertures are provided for the passage of the main shaft, and of turning, rocking, or sliding spindles for adjusting brushes or switches. They prevent the presence of an inflammable mixture of gases within the casing, whilst the electrical apparatus is working. by charging the interior with a sufficient quantity of carbonic acid gas, such gas being evolved electrolytically by the action of an electric current on any suitable chemical. 1 claim.

7,911. "An electric switch." G. S. GRIMSTON. Dated May 7th. Claim:—An electric switch wherein conducting bars, fitted to revolve on a central pin, are held in either of two positions by a spring pawl until by partly turning a handle the pawl is disengaged and the conducting bars are turned rapidly against a stop by the recoil of a spring strained by the movement of the handle, substantially as described.

CORRESPONDENCE.

Cost of Electric Supply.

In common, I am sure, with all your readers, I have been very much interested in Dr. Hopkinson's proposed alternative system of charging for current. I have not yet been able to work it out sufficiently in detail to see how it would affect the circuits in which I am most interested. But it occurs to me that it may be worth while pointing out that if such a system of charging for electrical energy should come into use, a necessary adjunct of the ordinary meter would be some form of maximum recording ampèremeter.

It would obviously be impossible to take as a maximum the particular number of lamps or points of connection applied for by a would be consumer. The mere fact that he could use 8 and 16-candle-power lamps entirely at will makes this impracticable. The notion of using the main fuse as a measure of maximum current is also obviously out of the question. But there would be no difficulty in requiring each customer to state (no doubt usually with the aid of his wiring contractor) the maximum current which he intends to consume, and I cannot suppose that the many engineers who are at work on the design of electrical instruments would have any trouble in scheming a simple form of current indicator, with a non-return pointer, which would be accurate within 2 or 3 per cent; quite as nearly as is necessary.

Alex. B. W. Kennedy.

November 25th, 1892.

Dry Leclanché Batteries.

Referring to the correspondence on the above in your issues of 11th and 18th inst., will you allow me to assure "Voltaic" that the Leclanché-Barbier patent cylindrical agglomerate dry cells (for which I am Messrs. Leclanché's sole agent in the United Kingdom and colonies), may be perfectly relied upon to do the work of ordinary wet cells, and have given complete satisfaction wherever used.

Mr. C. A. Gawthorp's letter gives a fair description of this cell; and Mr. R. T. Dick is quite right in saying that, strictly speaking, there is no such thing as a dry cell. All cells must contain moisture more or less, and in the dry form this is so little that they do not generally last as long as the wet ones, and when dried up the usual sealed up pattern of dry cell becomes useless to its owner

The speciality of the Leclanché-Barbier dry cell is that this is obviated by its peculiar construction in not being sealed up, and it can be easily renovated by letting it, when the strength of the current falls, absorb a little more ammoniacal solution, all excess of which is poured off, and the cell regains its full energy. The owner can thus maintain the efficiency of his dry batteries indefinitely at a merely nominal cost.

These dry cells will compare favourably with any others for their electrical qualities and moderate cost.

R. Aylmer.

The Dangers of Electric Lighting.

There has been a good deal said lately with reference to that poor man who lost his life while working on a "live high tension cable," about wearing gloves; taking proper precautions; not being allowed to work on cables while current is on without wearing gloves; and so on.

Now, Sir, with all due respect to the firms concerned (because according to their rules they are exonerated from all blame), I beg to be allowed to give my little experience as an electrical engineer on both sides of the Atlantic, on high as well as low tension systems. In the first place I was taught in my early days never to use gloves while working on a live wire; not because of the inconvenience, but because you can never depend on them, even if they are tested before you leave the station; they may crack at any time; and, if you depend on them, your life may be taken at any moment; whereas, if you do not use them at all, it makes you more careful, and I think, on the average, it is far safer to work on high tension systems without the gloves. I'll admit it is a good thing to tape your plyers for shipwork when the voltage is only 110, or less, especially on single wire jobs, as I have had many a good shock from the same; but when we come to high tension currents, when the voltage runs up as high as 10,000, and as, according to Prof. H. P. Brown, of the Franklin University, U.S.A., it takes about 360 volts alternating current and about 2,000 volts continuous to kill an average man, there ought to be a law to prevent anyone (no matter how skilled they may be) from working or doing anything whatever, gloves or no gloves, to any part of an high-tension system while the current is flowing, when it is at the risk of a man's life. I know, in my young days, I risked my life twice for the sake of keeping the lights going in a certain central station. I changed the brushes on a high-tension machine successfully while it was going, and without putting the lights out; but if I had moved an eighth of an inch, I might not be here now. It was not necessary for me to do so, I had the power of stopping the machine if I liked, or letting it run in a bad state till daylight, but being anxious that there should be a good light on the streets, I would risk anything to that end, but I would never do it now; I would stop the machine first.

In conclusion, I might mention that there ought to be more definite rules laid down in every supply station than what there appears to be for the protection of the workman.

If the Board of Trade were less particular about overhead wires and more particular over the lives of our workmen, it would be far better for the country at large.

Chas. Rettie.

Commercial Electrolysis.

In your issue of November 18th, you quote a correspondent's remarks *re* the discussion on Mr. Swinburne's paper, entitled, "The Problems of Commercial Electrolysis." In the first place, I must correct a little slip. Your correspondent writes: "Mr. Cooper speaks of his Hermite process." Allow me to say that the process was invented and worked out by Mr. Hermite, and, therefore, is Mr. Hermite's, and not mine. With regard to your correspondent's remark that I call my few words a discussion on commercial electrolysis, I must confess that I fail to see the reason for it. I was fully prepared to give figures upon the subject of the cost of bleaching by the Hermite process, but I thought it advisable to make a few remarks before doing so, and the President, or, rather, "Time," stepped in before I arrived at that point. I assumed (and I think I had a right to), considering the frequent descriptions which have appeared from time to time of the process, that I was talking to an audience who was fully aware that bleaching by electrolysis was going on upon a large scale on the Continent. I was addressing a body of men who are generally acknowledged to be "up to date," but I regret that your anonymous correspondent cannot be classed in that category. It is difficult to give exact figures as to the actual amount of paper pulp bleached by the Hermite process in one year, owing to the extraordinary variety of fibres which are being treated; but I think I am well within the mark in saying that Mr. Hermite is doing the equivalent amount of work to 3,000 tons of bleaching powder per annum, and bleaching about 23,000 tons of dry pulp per annum, consisting of jute, cotton, esparto, but principally sulphite and soda wood pulp. Considering that bleaching powder is quoted just now at about £8 per ton (in France it is much higher), and the cost of bleaching by the Hermite process may be taken at about half the cost of bleaching by bleaching powder, as testified to by the owners of paper mills, who have been working it for years, I think I may fairly claim to have spoken upon commercial electrolysis. I have made no mention of the numerous other adaptations of the process, such as disinfection, treatment of starch, &c., but hope to do so before long. Trusting that I have not trespassed too much upon your valuable space.

Charles F. Cooper (*Paterson & Cooper*).

Country House Lighting.

I notice in the Electrical Review, of November 25th, an article on a country house installation for Mr. Hanbury, at Poles, Herts; Mr. Segundo being consulting engineer. Great stress is laid on the system of distribution as therein described. Now, while at the same time recognising its many obvious advantages, I cannot allow that this system is either new or peculiar to one engineer.

Some time ago I arrived at the conclusion that this system was the only one that should be used, and I invariably specify that all wiring work shall be so carried out, which has been done in many cases under my direction, with notable success, at the Arts and Letters Club, Grafton Street; Residential Flats, Park Place, St. James's; 9, Princes Gardens; 66, Gracechurch Street, &c.

The great difficulty which I first met with was leakage from the quantity of slate required for the boards, but this I have now overcome by using a porcelain board made in small pieces to suit the number of points required, mounted in a wood frame. These were manufactured for me by Messrs. Appleton, Burby & Williamson, of Queen Victoria Street, E.C.

In conclusion, I can only hope that that this system will become general, and that electrical contractors will see that while the material cost, a fixed quantity, will be possibly 15 per cent. higher, the labour, a variable feature, will be less by at least 25 per cent.

Adrian Collins.

November 29th, 1892.

Solder.

I should be glad if you would kindly tell me in this week's Review what you consider is wrong with the enclosed solder. It is made according to the usual recipe, one part of block tin to two parts lead, and was melted in a clean iron ladle. It is too brittle to be of any use for soldering.

As I have several pounds run out, I should like to know how to treat it.

C. W. L.

[In theory, "tinman's" solder should be made in the proportion of one part lead and one part tin, and plumber's solder two parts lead and one part tin, but in practice much depends on the quality of the metals in deciding these proportions. For instance, after melting, if the solder runs too coarse it requires more tin, and if it is too fine more lead should be added. The sample submitted is not suitable for making a joint. Either the proportions are wrong, or what is more probable, the metals from which it has been made are of inferior quality. Was compo. pipe used for pure lead? If so, this will probably account for the non-success of the sample.—Eds. Elec. Rev.]